NUCLEAR SCIENCE ABSTRACTS

Volume 26 Number 6

Abstracts 11488-14654

March 31, 1972

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NOTICE

A title page for Volume 26, Numbers 1–6, is included at the back of this issue for use in binding those issues.

CORRECTIONS

NSA Vol. 25, No. 10, page 2239, line following "SHIELDING" should read: Refer also to 21506, 22618, 22620, 22945, 22947 and 23328.

Volume 26, Number 6, March 31, 1972

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Office of Information Services, John A. Harris, Director. Published by the USAEC Technical Information Center, Robert L. Shannon, Manager.

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary alloys V_3Si--Nb_3Al, 25:1093 (CALT-822-13)
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The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

TRANSURANIUM ELEMENTS
determination in bone ash, radiochemical method for, 25:40 (IDO-12073, pp 28-36)
separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
determination in luminescent material by scintillation ccunting, 25:40 (IDO-12073, pp 28-36)

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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009–1). Dep. NTIS.

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget, June 26, 1969.

Volume 26, Number 6 March 31, 1972

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstract 12022.

11488 (RT/CHI-(71)7) A NEW REMOTELY OPERATED PIPETTE FOR MICROQUANTITIES OF HIGHLY RADIOACTIVE SOLUTIONS. Orsello, S.; Pozzi, F.; Todini, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 18 May 1971. 18p. (In Italian). Dep. NTIS (U. S. Sales Only).

A remotely operated pipetter (CNEN patent 53608 A/70) for microquantities (200 to 1000 μl) of highly radioactive solutions is described. The basic pipetter's unit is a commercial micropipette, adapted to the remote manipulation by a suitable mechanical device; three of the pipetter's work in the analytical hot cells of the CNEN-EUREX reprocessing plant. The standard deviation percentile at the 95% confidence level, obtained with 2000 data, is in the range of 0.1%, with no bias. (auth)

11489 ELECTROCHEMICAL METHOD OF ISOLATING NEPTUNIUM FROM ALKALINE PEROXIDE MEDIUM. Gurevich, A. M.; Polozhenskaya, L. P.; Osicheva, N. P.; Solntseva, L. F. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 238-43(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 239-45(Mar-Apr 1971).

An electrolytic method was proposed for isolation of neptunium from peroxide-alkaline medium. The identity of the optimum conditions of quantitative isolation of uranium and neptunium in pure form and the conditions of their joint isolation from peroxide-alkaline medium were demonstrated. The applicability of the method to the analysis of salt solutions of neptunium in a broad range of concentrations of the latter was demonstrated. (auth)

11490 TREATISE ON ANALYTICAL CHEMISTRY. PART I. THEORY AND PRACTICE. VOLUME 9. Kolthoff, I. M.; Elving, Philip J. (eds.). New York; John Wiley and Sons, Inc. (1971). 564p. $24.95.

Seven chapters were abstracted separately for NSA. The remaining chapter deals with the topic, combination of physical and chemical properties for characterization and analysis. (J.G.B.)

For abstracts of individual chapters see: 11491-11493, 11504, 11536, 11568, and 11892.

11491 RADIOACTIVE AND ISOTOPIC METHODS OF ANALYSIS: NATURE, SCOPE, LIMITATIONS, AND INTERRELATIONS. Finston, H. L. (Brooklyn Coll.). pp 5385-5425 of Treatise on Analytical Chemistry. Vol. 9, Pt. I. /Kolthoff, I. M. (ed.). New York; John Wiley and Sons, Inc. (1971).

Various radioactive and isotopic methods of analysis are reviewed. Decay and growth and the theory of successive transformations are discussed. The nucleus is examined from the standpoint of nuclear particles, forces, and structure. The production of radionuclides by accelerators, nuclear reactors, and neutron sources is discussed. (J.G.B.)

11492 TRACE ANALYSIS: ESSENTIAL ASPECTS. Skogerboe, R. K.; Morrison, G. H. (Cornell Univ., Ithaca, N. Y.). pp 5835-5861 of Treatise on Analytical Chemistry. Vol. 9, Pt. I. /Kolthoff, I. M. (ed.). New York; John Wiley and Sons, Inc. (1971).

Trace analytical methods are examined as to their three component steps, sampling, chemical and/or physical pretreatment, and instrumental measurement. Absolute detection limits for various analyses, (absorption spectrophotometry, uv and visible fluorescence, atomic absorption, flame spectrophotometry, electrochemistry, emission spectrography, x-ray fluorescence, neutron activation, and mass spectroscopy) are given in nanograms for seventy-nine elements. Accuracy, precision, scope, and selectivity of the total analytical method are discussed. (30 references.) (J.G.B.)

11493 DETERMINATION OF PURITY. Stross, F. H.; Badley, J. H. (Shell Development Co., Emeryville, Calif.). pp 5863-5932 of Treatise on Analytical Chemistry. Vol. 9, Pt. I. /Kolthoff, I. M. (ed.). New York; John Wiley and Sons, Inc. (1971).

Current sources of information on standards of purity and the methods for its determination for specific materials are given. A basis for selection among alternative test methods is given, and the development or applicability of test methods for new materials is discussed. An attempt is made to assist in setting up realistic criteria for the purity of compounds. Separation techniques, including chromatography, liquid-liquid extraction, distillation, electrophoresis, and phase solubility analysis, are considered. Other topics discussed are: physical property measurements, chemical, electrochemical, colorimetric, spectroscopic, and radiochemical methods. (J.G.B.)

11494 CHELATE SORBENTS IN ANALYTICAL CHEMISTRY (A REVIEW). Myasoedova, G. V.; Eliseeva, O. P.; Savvin, S. B. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: No. 11, 2172-87(Nov 1971). (In Russian).

A review of the literature on chelate sorbents in analytical chemistry is given. The use of highly selective sorbents gives possibilities for solving such complex analytical problems as the separation of elements with similar ion properties and isolation of microamounts of elements from salt solutions. There are many types of chelate resins with various functional-analytical groups, but their synthesis is difficult, which prevents their wide use in analysis. (auth)

Chemical and Spectral Procedures

Refer also to abstract 12176.

11495 (IS-2739) BIBLIOGRAPHY OF MASS SPECTROSCOPY LITERATURE FOR 1970 COMPILED BY A COMPUTER METHOD. Capellen, J.; Svec, H. J.; Jordan, J. R.; Sun, R. (comps.) (Ames Lab., Iowa). Jan 1972. Contract W-7405-eng-82. 895p. Dep. NTIS.

This report covers the year 1970, and lists 8822 articles of interest to mass spectroscopists. The report consists of three sections: a bibliography, an author index, and a key word out of context index (KWOC index). The bibliography lists the authors, the title, and the publication data for each article. The author index lists the authors' names and the reference numbers of their articles. The KWOC index lists the key words, the reference numbers of the articles in which the key word appears and the first 100 characters of the title. (auth)

11496 DETECTION OF URANIUM BY PHENOL. Tsubaki, Isamu; Nakanishi, Tsutomu (Osaka Electro-Communication Univ., Neyagawa, Japan). Jap. Anal.; 20: No. 8, 1033(Aug 1971). (In Japanese).

The color reaction of uranium(VI) with phenol was applied to

the detection of uranium(VI). A drop of the sample solution was added on a drop of phenol solution on a porcelain plate. Uranium gave a brown to pale yellow color depending on its amount. Iron (III), cerium(IV), and molybdenum(VI) gave a similar coloration, but the color by iron and cerium disappeared by reducing them to Fe(II) and Ce(III). Phenol is thus useful as a reagent for uranium(VI) which is more specific than thiocyanate, ferrocyanide, oxine, and Rhodamine B. (auth)

11497 SPECTRAL DETERMINATION OF CARBON USING ISOTOPIC EQUILIBRATION. Zakorina, N. A.; Lazeeva, G. S.; Petrov, A. A.; Stolbova, E. P. Vestn. Leningrad. Univ., No. 4, Fiz., Khim.; No. 1, 141-3(Feb 1971). (In Russian).

A hot hollow cathode was used for isotope analysis of carbon with the bands of the CO^+ ion and for determination of carbon isotope composition in organic substances. The estimation of the total content of carbon in organic samples was made by means of a spectral isotopic method. (auth)

11498 POLAROGRAPHIC INVESTIGATION OF METHYL-THYMOL BLUE AND ITS COMPLEX WITH ZIRCONIUM WITH APPLICATION OF A ROTATING PLATINUM ELECTRODE. Tserkovnitskaya, I. A.; Borovaya, N. S. (Leningrad State Univ.). Vestn. Leningrad. Univ., No. 4, Fiz., Khim.; No. 1, 71-4(Feb 1971). (In Russian).

Polarographic behavior of Methyl Thymol Blue and its complex with zirconium was investigated on a rotating platinum electrode disk in the range of pH = 1 to 5. (auth)

11499 ANALYSIS OF THE MASS-SPECTROMETRIC DOUBLE-BEAM METHOD FOR THE DETERMINATION OF ISOTOPE ABUNDANCE VARIATIONS. Dostal, K.-P. (Zentralinstitut fuer Isotopen- und Strahlentechnik, Leipzig). Isotopenpraxis; 7: No. 7, 305-8(Jul 1971).

The mass-spectrometric errors of measurement are considered. Four possibilities of measuring are described: rare isotope voltage is divided, calibration with standard; rare isotope voltage is divided, calibration with sample; abundant isotope voltage is divided, calibration with standard; and abundant isotope voltage is divided, calibration with sample. The effect of pressure inequality between sample and standard on δ-value is shown. (M.C.G.)

11500 DETERMINATION OF IODIDE IN FEEDS AND PLANTS BY ION-SELECTIVE ELECTRODE ANALYSIS. Hoover, William L.; Melton, James R.; Howard, Peggy A. (Texas A and M Univ., College Station). J. Ass. Offic. Anal. Chem.; 54: No. 4, 760-3(Jul 1971).

A method for determining low levels of iodide in feeds and plants is proposed. The samples are mixed with a 10% phosphate solution to maintain relatively constant ionic strength and pH and analyzed with a solid-state iodide electrode. Ashing is not required, and there are no significant interferences by ions commonly found in feeds. The method is accurate in determining iodide content ranging from 10.0 ppM to high concentrations. Necessary conditions for storing and cleaning the electrodes are described. The proposed method is rapid, and results compare favorably with other methods. (auth)

11501 FLUORINE, CHLORINE, BROMINE, AND IODINE CONTENTS OF VOLCANIC ROCKS IN JAPAN. Yoshida, Minoru (Tokyo Inst. of Tech.); Takahashi, Kazuyoshi; Yonehara, Norinobu; Ozawa, Takejiro; Iwasaki, Iwaji. Bull. Chem. Soc. Jap.; 44: No. 7, 1844-50(Jul 1971).

The halogen contents of 49 Japanese volcanic rocks are: F, 50 to 1700 (average 410); Cl, 17 to 1220 (average 270); Br, 0.09 to 8.10 (average 0.85); and I, 0.011 to 0.32 (average 0.088) μg/g. The fluorine and chlorine were determined by usual photometric methods, and the bromine and iodine, by photometric methods based on their catalytic action, after decomposition and separation procedures suitable for each case. Bromine and iodine content are appreciably lower than the values generally accepted for igneous rocks. The frequency distribution of each halogen content shows an approximate lognormality. The chlorine and bromine contents are strongly correlated, and the Br : Cl atomic ratio is in a narrow range (0.66 to 3.7) $\times 10^{-3}$ (average 1.5×10^{-3}). No other correlation is observed among the halogen contents at all. Each halogen content has no marked relation to the type of rock. A regional difference is seen in the F : Cl and I : Br ratios. Three ultrabasic rocks have very low fluorine (≤20) and chlorine content (≤50 μg/g). On the other hand, they have a slightly lower bromine content (0.15 to 0.34 μg/g) than, and almost the same iodine content (0.07 to 0.13 μg/g) as, the volcanic rocks. (auth)

11502 CONTROLLED-POTENTIAL DETERMINATION OF URANIUM(VI) IN THE PRESENCE OF NITRATE. Sobkowska, A. (Inst. of Nuclear Research, Warsaw). Radiochem. Radioanal. Lett.; 8: No. 6, 357-62(31 Dec 1971).

The coulometric determination of uranium in the presence of nitrate is described. The best results were obtained with sulfamic acid or hydrazine as nitrite destroyers. (auth)

11503 SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM AFTER EXTRACTION OF THE Mo(VI)-Sn(II)-CNS SYSTEM BY A HIGH MOLECULAR WEIGHT AMINE. Khattak, Mohammad Akram (PCSIR Labs., Peshawar, Pakistan). Pak. J. Sci. Ind. Res.; 14: No. 1-2, 43-6(Feb-Apr 1971).

An investigation of the complex formed between molybdenum(VI) and thiocyanate in the presence of Sn(II) in hydrochloric acid solutions was carried out, and its extractability by a high-molecular-weight amine (HMWA) in organic solvent examined. The orange colored Mo(VI)–Sn(II)–CNS complex is quantitatively extractable from an aqueous phase into an organic phase containing tribenzylamine. On the basis of this extractability a method was developed for spectrophotometric determination of molybdenum in presence of many other elements. Comparison of the absorption spectra of the colored species in the aqueous and amine phases indicate the presence of the same absorption species in each medium. The extractability of the complex by a HMWA suggests that the colored species is anionic. (auth)

11504 NUCLEAR RADIATIONS: CHARACTERISTICS AND DETECTION. Finston, H. L. (Brooklyn Coll.). pp 5427-5465 of Treatise on Analytical Chemistry. Vol. 9, Pt. I. /Kolthoff, I. M. (ed.). New York; John Wiley and Sons, Inc. (1971).

Topics discussed are: interactions of nuclear radiations with matter; radiation detection and measurement, including photographic and ion collection methods, scintillation and solid-state detectors; instrumentation for radiation detection; and, analytical applications of radiochemical and nuclear techniques. (J.G.B.)

11505 PHOTOMETRIC DETERMINATION OF TRACES OF TELLURIUM WITH UNITHIOL [SODIUM 2,3-DIMERCAPTOPROPANESULPHONATE]. Ramanauskas, E.; Grodnikas, Sh. Liet. TSR Aukst. Mokyklu Mokslo Darb., Chem. Chem. Technol.; No. 11, 11-17(1970). (In Russian).

Silicon, Ca, Mg, Al, Mo, Sn(IV), and small amounts of Cu, Sn(II), Sb(III), Zn, Cd, and Bi do not interfere, but Ag, Hg(II), Mn(II), Ni, Pb, Fe, Ti(III), Se(IV), Cr, Co, and W(VI) form colored compounds with unithiol. The method is suitable for determining Te in selenium (after separation of Se(IV) by reduction to elementary Se with ascorbic acid) and in salts of Pb (after separating Pb by anion exchange). (Referativnyi Zh.)

11506 PORTABLE RADIOISOTOPE X-RAY FLUORESCENCE ANALYZER AND ITS APPLICATIONS. Tanemura, Takashi; Suita, Hiroshi; Yamamoto, Hidenobu (Rigaku Denki Co., Ltd., Tokyo). Radioisotopes (Tokyo); 20: No. 9, 438-44(Sep 1971). (In Japanese).

Characteristic features of a new portable radioisotope x-ray fluorescence analyzer and an experimental study on its applications are described. This apparatus consists of a probe and an electronic unit, whose weights are 1.7 kg and 7 kg, respectively. Analysis of alloys, minerals, and other samples was studied. Detection limits of the order of 10 ppM were obtained in the analysis of Cu in aluminum alloy, V, Zr, Mo, and W in alloy steel. In the practical application of alloy sorting, the difference of 0.2% of the above-mentioned elements can be discriminated in the short time from one to three seconds. Four and five seconds are required for the discrimination of the difference of 1% for Cr and Ni in alloy steel. In the analysis of mineral samples, a linear calibration line without matrix correction can be ordinarily applied for the determination of elements above 1% in concentration. Relative error is 10% for the element 1% in mean concentration, relative error below 3% for the element above 15% in mean concentration. In the determination of Mn in aqueous solution and Mn deposited on a filter paper, detection limits were as low as 10 ppM and 2.2 μg/cm², respectively. (auth)

11507 SPECTRA OF RARE EARTH ELEMENTS FOR THEIR DETERMINATION IN MINERALS. Kul'skaya, O. A.; Shkvaruk, R. N.; Kozak, S. A. Zh. Prikl. Spektrosk.; 15: No. 2, 195-9(Aug 1971). (In Russian).

A method was developed for the direct quantitative determination of rare earth elements in minerals. Experimental conditions were selected, which assured fractional vaporization (electrode form and exposure schedule), with graphite added as a diluent. Preparation of two series of standards is described. (K.S.W.)

11508 RARE-EARTH, YTTRIUM, AND SCANDIUM GEOCHEMISTRY OF THE OKA CARBONATITE COMPLEX, OKA,

QUEBEC. Eby, George Nelson. Boston; Boston Univ. (1971). 263p. University Microfilms Order No. 71-26,403.
Thesis.

As part of a study of the rare earth, yttrium, and scandium geochemistry of the Oka carbonatite complex, Oka, Quebec, a combined chemical and x-ray fluorescence procedure was developed, which permits determination of these elements to the microgram level. The rare earth elements, yttrium, and scandium are first separated as a group by ion exchange and the concentrations of the various elements are then determined by x-ray fluorescence. Comparison of values obtained for the U.S.G.S. standard rocks using this method with those previously reported in the literature indicates relatively good agreement (10 to 30%) to the ppM level. (TSS) (Diss. Abstr. Int., B)

11509 SPECTRAL DETERMINATION OF HAFNIUM IN ZIRCONIUM OXIDE. Popa, Lucretia I.; Beke, Elena (Institut de Physique Atomique, Bucharest). Rev. Roum. Chim.; 16: No. 8, 1247-53(Aug 1971). (In French).

The amount of hafnium in zirconium oxide was determined by electric arc emission spectrography. The methods for the determination of hafnium in zirconium oxide were studied thoroughly for small concentrations of hafnium. The lines used were: Hf I 3072.87; Hf II 2866.3; Zr II 3086.46; and Zr II 2859.6. (E.J.H.)

11510 CHEMICAL CHARACTERIZATION OF URANIUM NITRIDES. Tennery, V. J.; Botts, J. L. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 13: No. 3, 264-72(Mar 1972).

Chemical analysis techniques were demonstrated for three uranium nitride specimens. Sintered uranium mononitride (UN), unsintered UN powder, and $UN_{1.572}$ powder were analyzed for the major constituents and a mass balance of 100.00 ± 0.03% was realized in every case. The gravimetric determination of uranium in these materials by an oxidation–reduction–oxidation method gave good precision and accuracy. Results from the direct oxidation method were strongly dependent upon the oxygen content of the gas used to oxidize the sample. The controlled-potential coulometric method was used to confirm the gravimetric uranium results. The Dumas method for nitrogen determinations was shown to be superior to the Kjeldahl both for UN and $UN_{1.572}$. Inert gas fusion is suitable for the determination of oxygen and a conventional combustion method is suitable for carbon determinations. Sintered UN provided a mass balance of 99.989% with a mole ratio N + O + C/U = 0.997 and a crystal lattice parameter a = 4.8896 ± 0.0001 Å. The microstructure of this sample consisted of single phase mononitride. (auth)

11511 DETERMINATION OF TRACE AMOUNTS OF OXYGEN IN METALS BY SPARK SOURCE MASS SPECTROMETRY. Beske, H. E. (Kernforschungsanlage, Juelich, Ger.). Z. Anal. Chem.; 256: No. 2, 103-5(1971). (In German).

Oxygen was determined in the ppM range in Cu, brass, Ta, Al, and Si. The procedure offers the advantage that the oxygen content can be determined without additional expenditure from the same mass spectra employed for production control in the preparation of high-purity substances. (auth)

11512 DETERMINATION OF CADMIUM, COBALT, CHROMIUM, MAGNESIUM, MANGANESE, AND NICKEL IN URANIUM COMPOUNDS BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Jaros, Jaroslav. Jad. Energ.; 17: No. 9, 307-11(Sep 1971). (In Czech).

A method for the determination of Cd, Co, Cr, Mg, Mn, and Ni in nuclear pure uranium and its compounds by atomic absorption spectrophotometry is described. After the separation of uranium by extraction with tributyl phosphate, the individual elements are determinated in an aqueous phase. This procedure permits concentrations down to 0.01 μg/g Mg, 0.02 μg/g Cd, 0.06 μg/g Cr, 0.06 μg/g Mn, 0.13 μg/g Co, and 0.17 μg/g Ni to be determined. The coefficients of variation of the elements determined are in the margin 2.2 to 4.5%. Results are in good accordance with results from spectrographic and spectrophotometric analyses. The behavior of the elements and the interferences of Al, Fe, P, Si, and U were checked. (auth)

11513 CESIUM DETERMINATION WITH AMMONIUM DIAMMINETETRATHIOCYANATOCHROMATE. Bagbanly, I. L.; Shirai, M. V. (Inst. of Inorganic and Physical Chemistry, Baku). Azerb. Khim. Zh.; No. 5-6, 120-3(1970). (In Russian).

The gravimetric determination of Cs in the presence of Na, K, and Rb was investigated, using a 3% aqueous solution of $NH_4[Cr(CNS)_4(NH_3)_2] \cdot H_2O$ as a precipitating agent in twofold excess. The completeness of Cs removal from the solution was estimated to be 98.8%, and no contamination of the Cs complex by Na, K, or Rb was detectable. (K.S.W.)

11514 EXTRACTION OF HEXAFLUOROTANTALATE [IN DETERMINATION OF TANTALUM] WITH BRILLIANT GREEN [C.I. BASIC GREEN 1]. Bausova, N. V.; Lebedeva, E. M. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 17, 195-200 (1970). (In Russian).

Optimum conditions were established for the extraction of TaF_6^- as an ionic association complex with Brilliant Green. The complex is best extracted into benzene from an aqueous solution of 2N H_2SO_4 or 4N H_3PO_4, or into toluene from a 2N H_2SO_4 or N H_3PO_4 solution. The concentration of F^- must be <0.3N and that of H_2SO_4 > 0.5N. The extracts, the color of which is stable for ≈3 hr, are suitable for the photometric determination of Ta. (Referativnyi Zh.)

11515 COMBINED ELECTRODEPOSITION–PHOTOMETRIC METHOD FOR DETERMINING NIOBIUM AND TITANIUM IN MAGNETIC ALLOYS OF TITANIUM. Bagdasarov, K. N.; Osmanov, Kh. A. Tr. Novocherkassk. Politekh. Inst.; 220: 78-83 (1969). (In Russian).

Conditions were established for the electrodeposition (on a polished platinum cathode) of elements that interfere with the determination of Nb and Ti in such alloys. First, Cu is deposited from an ethyl ether–H_2SO_4 medium of pH 1.5 to 1.6 at 38° to 40° and −0.2 V. Then the pH is adjusted to 5.6 to 5.7 and electrolysis is carried out at −1.0 V; after 10 min the potential changes to −1.05 V, and after 20 min it becomes −1.1 V; Ni, Co, and Fe are deposited in this stage. In the residual solution Nb is determined photometrically with 4-(2-pyridylazo)-resorcinol or Acid Chrome Violet (C.I. Mordant Violet 5), and Ti with sulfosalicylic acid, chromotropic acid, or bromopyrogallol red. (Referativnyi Zh.)

11516 PHOTOMETRIC DETERMINATION OF NIOBIUM IN THE PRESENCE OF TANTALUM, TITANIUM, RARE EARTH METALS, AND OTHER ELEMENTS. Tatarskaya, A. Z.; Talipov, Sh. T.; Dzhiyanbaeva, R. Kh. Izv. Akad. Nauk Tadzh. SSR, Otd. Fiz.-Mat. Geol.-Khim. Nauk; 1: No. 35, 47-9(1970). (In Russian).

Niobium can be determined (in tartaric acid medium) in the presence of a high concentration of elements usually associated with it in industry or nature, by using as reagent diethylamino-2-[3-(1-methyl-2-piperidyl)-2-pyridylazo]phenol or 4-[3-1-methyl-2-piperidyl)-2-pyridylazo]resorcinol (I or II, respectively). With I, the 25 ml of solution used for photometry contains 2 g of tartaric acid, 15 ml of acetate–HCl buffer solution of pH 5.57 and 1 ml of 0.2% ethanolic reagent. With II, the solution is 0.025 M in EDTA, contains 1 ml of ethanolic reagent and 20 mg of tartaric acid and is buffered at pH 5.8. Color is developed by warming the mixture to 80°, and the extinction is measured after 30 min. With I, Nb equivalent to 30 μg of Nb_2O_5 can be determined to within ±7% in the presence of up to 60 μg of Fe, 150 μg of Ta_2O_5, Zr or Th, 300 μg of TiO_2 or 1500 μg of Ce, Mo, or Y. With II, there is no interference from a 300-fold amount of Mo or W, a 20-fold amount of Ce or Th or a 3-fold amount of Ta, Zr, Ti, or V. (Referativnyi Zh.)

11517 PHOTOMETRIC DETERMINATION OF LANTHANUM AND CERIUM IN SALTS OF RARE EARTH ELEMENTS OF THE YTTRIUM SUBGROUP. Sandu, M. A.; Poluektov, N. S.; Lauer, R. S. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 37: No. 8, 820-6(Aug 1971). (In Russian).

The reaction of rare earth ions with Bromopyrogallol Red (dibromopyrogallolsulfophthalein, BPR) was investigated, and the conditions for a photometric determination of individual rare earth elements of one subgroup in the presence of elements of another subgroup were studied. Controlled determinations were made of La_2O_3 and Ce_2O_3 in admixtures with Gd_2O_3 and Y_2O_3, respectively. Urotropine or an acetate buffer was used to control the pH. Standing for 24 hr at room temperature was required for the reaction to attain completion. Two maxima in the absorption spectra of the rare earth–BPR complexes were observed: 568 nm and 668 to 642 nm. The molar coefficient of absorption for the series of complexes was studied as a function of the atomic number of the rare earth; the molar coefficient decreased from La to Nd, increased from Nd to Gd, and thence constantly decreased through Lu. The reaction postulated requires that one atom of rare earth reacts with 2 molecules of BPR. Further study of the effect of varying the pH was conducted. (K.S.W.)

11518 ANALYSIS OF TRACE STATE IMPURITIES IN U USING MASS SPECTROMETRY AND ISOTOPIC DILUTION PRECEDED BY ELECTROCHEMICAL SEPARATION. Golightly, D. W. (CEN, Grenoble, France). Method. Phys. Anal.; 7: No. 3, 275-9(Sep 1971). (In French).

A technique applicable to B, Cr, Cu, Fe, Mo, and Ni analysis in high purity U is described. After the addition of stable isotope

tracers to the U solution, the elements sought are deposited on two high purity Au cathodes. These cathode deposits are then sparked and their isotopic rations determined. Two U samples, characterized by other methods, were used to test and verify the exactness of this technique. Six impurities between 0.4 and 70 ppM (by weight) were quantitatively titrated in 1 to 2 g of U. (France)

11519 QUANTITATIVE SEPARATION OF OXYGEN FOR ISOTOPIC ANALYSIS FROM NATURAL AND SYNTHETIC MATERIALS BY MEANS OF HEXAFLUOROBROMOCESIUM COMPOUNDS. Sukhoverkhov, V. F.; Ustinov, V. I.; Grinenko, V. A. (Inst. of General and Inorganic Chemistry, Moscow. Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: No. 11, 2166-71(Nov 1971). (In Russian).

A method is suggested for the quantitative determination and isotopic analysis of oxygen in various inorganic materials and minerals of natural origin. (auth)

11520 INCREASING THE SENSITIVITY OF THE SPECTROGRAPHIC DETERMINATION OF NIOBIUM AND TANTALUM AS IMPURITIES IN ZIRCONIUM DIOXIDE AND THE USE OF TEFLON AS A FLUORINATING AGENT. Tarasevich, N. I.; Semenenko, K. A.; Khramova, G. T. (Moscow State Univ.). Zh. Anal. Khim.; 26: No. 11, 2149-54(Nov 1971). (In Russian).

By studying the process of vapor generation of niobium and tantalum pentoxides and zirconium dioxide and their evaporation rate the impossibility of using the method of spectral energies for increasing the sensitivity of determining niobium and tantalum as impurities in zirconium dioxide was shown. For increasing the vapor generation rate of the impurities, poly(tetrafluoroethylene) (Teflon) was used as a fluorinating agent. Conditions for fluorinating niobium and tantalum pentoxides in the carbon electrode crater were studied experimentally, and the limit of detection in zirconium dioxide estimated as 2×10^{-8} g for niobium by the line Nb II 3094.18, 6×10^{-8} g for tantalum by the line Ta I 2714.67. (auth)

11521 BENZENESULFOHYDROXAMIC ACID AS AN EXTRACTION-PHOTOMETRIC REAGENT FOR NIOBIUM(V). Gibalo, I. M.; Voskov, V. S.; Kulikova, L. N.; Lobanov, F. I. (Moscow State Univ.). Zh. Anal. Khim.; 26: No. 11, 2145-8 (Nov 1971). (In Russian).

Protonization of benzenesulfohydroxamic acid in hydrochloric acid solutions was studied and its protonization constant determined as $K_{pr} = (3.1 \pm 1.4) \times 10^{-2}$. The effect of the hydrochloric acid concentration on the formation of a colored compound of niobium with benzenesulfohydroxamic acid was examined. Its composition was established and the formation constants calculated. An extraction–photometric method was developed for determining niobium in alloyed steels. (auth)

11522 RAPID DETERMINATION OF GERMANIUM BY A PHENYLFLUORONE METHOD IN THE PRESENCE OF MOLYBDENUM AND VANADIUM. Dranitskaya, R. M.; Gavril'chenko, A. I.; Karpii, N. L.; Palei, L. N. (Odessa State Univ.). Zh. Anal. Khim.; 26: No. 11, 2137-41(Nov 1971). (In Russian).

The possibility was studied of masking molybdenum and vanadium with tartaric, citric, and oxalic acids and eliminating the vanadium effect with sodium sulfite and ferrous sulfate during the determination of germanium by a photometric phenylfluorone method. The best masking agent for molybdenum was oxalic acid, for vanadium it was citric acid. (auth)

11523 SPECTROPHOTOMETRIC DETERMINATION OF THE DISSOCIATION CONSTANTS OF ARSENAZO M AND ITS COMPLEXES WITH THE RARE EARTH ELEMENTS. Spitsyn, P. K.; Shvarev, V. S.; Korepina, M. E. (Gorky State Univ., Sverdlovsk, USSR). Zh. Anal. Khim.; 26: No. 11, 2121-6(Nov 1971). (In Russian).

The acid dissociation constants of Arsenazo M and the dissociation constants of complex compounds of all the rare earths with Arsenazo M were determined spectrophotometrically. A method is suggested for determining certain rare earths, which is based on using the differences in masking action by Complexone III in the reactions between the rare earths and Arsenazo M. (auth)

11524 SEPARATE DETERMINATION OF CHLORINE, BROMINE, AND IODINE WHEN THEY ARE PRESENT TOGETHER. Skorobogatova, V. I.; Kravchenko, G. A.; Faershtein, Yu. M. (Irkutsk Inst. of Organic Chemistry, USSR). Zh. Anal. Khim.; 26: No. 11, 2201-4(Nov 1971). (In Russian).

The decomposition of halogen-containing substances in an oxygen-filled flask was studied. Organic substances containing chlorine are decomposed with the liberation of only chloride ions. Bromine- and iodine-containing organic substances form, on decomposition, bromide and iodide ions and some amounts of elemental bromine and iodine. On adding hydrazine sulfate directly to the sample before decomposition all the halogens are obtained as halides, which then can be determined by mercurimetric or potentiometric titration. (auth)

11525 POTENTIOMETRIC DETERMINATION OF URANIUM AND PLUTONIUM IN T'IE MIXED OXIDES. Kato, Yoshiharu; Yamamoto, Tadashi; Muto, Hiroshi; Kihara, Sorin; Motojima, Kenji (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: No. 11, 627-31(Nov 1971). (In Japanese).

The potentiometric method was established for the determination of uranium and plutonium in mixed oxide samples. A weighed sample was dissolved in a HNO_3–HF mixture. The plutonium is oxidized to the hexavalent state with Ag(II) oxide in nitric acid solution, and the excess oxidant is destroyed with sulfamic acid. A known small excess of Fe(II) sulfate solution is then added to reduce the Pu(VI) to Pu(IV), and the excess is titrated potentiometrically with standard Ce(IV) sulfate solution. The total amounts of uranium and plutonium are obtained by reduction with Cr(II) sulfate and titration with standard Ce(IV) sulfate. The amount of uranium is calculated by subtracting the amount of plutonium. This method is suitable for the determination of 5 to 90% plutonium in mixed oxide samples. The coefficient of variation was 0.07 to 0.32% for 5 to 90% plutonium when more than 10 mg of mixed oxides were analyzed. (auth)

11526 AUTOMATIC DETERMINATION OF THE CONCENTRATION OF LANTHANIDES IN A STREAM DURING THEIR CHROMATOGRAPHIC SEPARATION WITH DIETHYLENETRIAMINE-PENTA-ACETIC ACID. Sheptunov, V. N.; Nazarov, P. P.; Sokolov, V. A.; Chmutov, K. V. (Inst. of Physical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 5, 734-5(May 1971).

Translated from Zh. Fiz. Khim.; 45: No. 5, 1289-91(May 1971).

The possibility of the automatic recording of the changes in the optical density of a solution flowing from a chromatographic column using an SF-4A spectrophotometer, an EPP-09 pen recorder, and a flow-type cuvette was demonstrated. The relative error in determination of neodymium in the chromatographic separation of a neodymium–cerium mixture using diethylenetriaminepenta-acetic acid is 0.2 to 0.3%. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 11883, 12119, 12137, 12282, and 14108.

11527 (UARAEE–113) RADIOMETRIC METHOD FOR THE DETERMINATION OF URANIUM CONTENT IN ORES AND ROCKS, USING SINGLE CHANNEL ANALYZER. Abdel-Aziz, M. M. (Atomic Energy Establishment, Cairo (Egypt). Geology and Raw Materials Dept.). 1971. 15p. Dep. NTIS (U. S. Sales Only).

The main function of the U.A.R.A.E.E. is to carry on and encourage different research work in the peaceful uses of nuclear energy. One of the important topics is radiometric analysis for the radioactive isotopes present in ores. The theory and techniques of gamma spectroscopy were used to establish a method for the rapid detection of uranium in ores and rocks and its quantitative assay. The 93- and 184-keV peak counting rates of both a uranium standard and an unknown sample are measured and the uranium in the sample can then be calculated. (M.C.G.)

11528 RAPID METHOD OF DETERMINING THE RADIOCHEMICAL PURITY OF PREPARATIONS LABELED WITH TRITIUM, USING PAPER AND THIN-LAYER CHROMATOGRAPHY. Vdovenko, V. M.; Bobrova, V. N.; Zharkov, A. V.; Rys'ev, O. A.; Volina, V. V. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 254-7(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 255-9(Mar-Apr 1971).

During the study of the radiochemical purity of a large number of biologically active substances labeled with tritium, the effectiveness of recording the soft β radiation of tritium in paper and thin-layer chromatograms with stilbene introduced was determined. The efficiency of recording fluctuated in the range 8 to 12%, depending on the physicochemical properties of the preparations and the layer of the carrier. The value obtained was 10 times as great as the count efficiency of tritiated preparations in paper chromatograms by the ionization method. The scintillation method of measuring dry paper and thin-layer chromatograms permits automation of the measurement of the distribution of tri-

tiated preparations on the chromatograms without impairing their intactness. The increase in the sensitivity of measuring devices opens up the possibility of studying processes of radiolysis of tritiated biologically active preparations, which is of interest both from the theoretical and from the purely practical standpoint. The simplest example of the practical application of these data is the selection of the conditions of storage and purification of the synthesized radioactive preparations. (auth)

11529 ION-EXCHANGE PURIFICATION OF ^{90}Y IN THE ANALYSIS OF ^{90}Sr IN SAMPLES OF SEA WATER. Bondarenko, G. N.; Baksheeva, I. P.; Dubrova, L. N. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 326-8(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 314-16(Mar-Apr 1971).

Samples of ^{90}Sr in seawater obtained in the 19th to 22nd voyages of the ship "Mikhail Lomonosov" were contaminated with ^{95}Zr + ^{95}Nb. In treatment of the samples according to the generally accepted precipitation method, the ^{90}Y isolated is accompanied by ^{95}Zr + ^{95}Nb, which does not permit determination of the activity of ^{90}Sr in the contaminated samples. The use of ion exchange purification of ^{90}Y from ^{95}Zr + ^{95}Nb on a cation exchange resin from a solution of citric acid with pH = 3 permitted the radiochemically pure ^{90}Y to be obtained from contaminated samples of seawater. (auth)

11530 USE OF THE STRONGLY BASIC ANION EXCHANGE RESIN AV-17 FOR THE ISOLATION AND PURIFICATION OF THORIUM. II. Tikhomirov, V. K.; Petrukhin, N. V. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 331-3(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 318-20(Mar-Apr 1971).

Microquantities of ^{234}Th can be isolated from samples containing large amounts of soluble salts, by sorption on the anion exchange resin AV-17 from 11N nitric acid. When the analysis is performed, a carrier, ^{232}Th, should be introduced into the sample. This method can also be used to determine isotopes ^{235}U and ^{238}U in samples according to the measured β-activity of ^{231}Th and ^{234}Th. (auth)

11531 RADIOMETRIC DETERMINATION OF URANIUM AND THORIUM IN SULFURIC ACID SOLUTIONS. Anosov, V. V.; Gavrilov, N. I.; Smelkova, T. P. At. Energ. (USSR); 31: No. 6, 633-5(Dec 1971). (In Russian).

A gamma spectrometric method for the simultaneous determination of U and Th has been developed which obviates any complex chemical pretreatment of the sample. This method utilizes the photopeaks in the gamma energy spectra chiefly of UX_1 in equilibrium with ^{238}U, and RaTh in equilibrium with decay products. The contributions of ^{235}U, TnX, ThB, $MsTh_1$, and $MsTh_2$ were also considered in the calculations. (K.S.W.)

11532 ANALYSIS OF BACKSCATTERED IONS AS A TECHNIQUE FOR THE STUDY OF SURFACES. Armour, D. G.; Carter, G. (Univ. of Salford, Eng.). J. Phys., E (London); 5: No. 1, 2-8(Jan 1972).

When energetic ions strike a surface, a fraction, depending upon the ion energy and other parameters, penetrate the surface, whilst the remainder are reflected or backscattered. This review shows how studies of the energy and angular distribution of backscattered ions is being used to investigate the composition of the surface and near surface of a solid, the location of impurities in a lattice, and the orientation and crystallinity of solids. The apparent limitations and prospects for development of this technique, as a precise analytical tool, are discussed. (auth)

11533 DETERMINATION OF THE DURATION OF GAMMA-SPECTRAL ASSAYING OF URANIUM–THORIUM ORES. Sinitsyn, A. Ya. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 107-12(1969). (In Russian).

On the basis of the statistical error in the count rate in separate point and area logging curves, obtained during logging of U and Th ores, and also the error in the determination of U and Th contents in ore strata, it is proposed to use for the integration of gamma spectral data the areas of logging diagrams S (imp/min), together with the count rate N (imp/min). This sometimes abbreviates the duration of measurements in separate points practically without deterioration in accuracy in U and Th determinations. (tr-auth)

11534 RADIOCHEMICAL DETERMINATION OF ^{214}Pb AND ^{214}Bi IN RAIN WATER. DISCUSSION OF THE POSSIBLE ROLE OF ^{222}Rn DAUGHTER NUCLIDES IN PRODUCTION OF ELECTRICAL STORMS. Michaelis, Martin L. Chem.-Ztg., Chem. App.; 93: No. 22, 883-95(1969). (In German).

The components of atmospheric radioactivity are discussed, and a description is given of methods tested for the determination of radium B(^{214}Pb) and radium C(^{214}Bi) in rainwater. Small samples (<40 ml) are counted directly. For samples of 40 to 500 ml, the sample is mixed with 10 ml of a Pb–Bi carrier solution [0.5% each of $Pb(NO_3)_2$ and $Bi(NO_3)_3$ in 5M HNO_3; the HNO_3 acts as a carrier for Po], then diluted to 500 ml, and 40 ml of a 25% Na acetate solution is added as a buffer. Then 50 ml of 2% 8-hydroxyquinoline in N-acetic acid is added, and the mixture is titrated, with stirring, with 5M aqueous NH_3 to a final pH of 9.75 ± 0.25. A coarse yellow precipitate of the mixed complexes of Bi and Pb is formed, and counted in a well-type NaI crystal or a poly-(methylstyrene) plastic scintillator. By appropriate pulse-height discrimination, the plastic scintillator functions as a selective detector for ^{214}Bi. Methods of preparing calibration standards and the isolation of ^{214}Bi free from ^{214}Pb are discussed in detail, as well as the errors involved in determining these radionuclides in rainwater. A preliminary determination of the extent of conversion of ^{226}Ra into ^{214}Pb and ^{214}Pb can be effected by activation with emanation from ^{212}Pb–^{212}Bi, and registration of the 2.62-MeV γ rays of ^{208}Tl with a NaI scintillation spectrometer. (Anal. Abstr.)

11535 METHOD OF MONITORING THE FLOW OF FISSILE MATERIAL. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,251,467. 27 Oct 1971. Priority date 28 Aug 1969, Germany.

A method of monitoring the flow of fissile material and for determining the quantity and isotopic composition of fissile material inventory present in a process is described. The total mass and the isotopic composition of the fissile material are measured qualitatively and quantitatively during a predetermined time at both the input and output of the process. (M.C.G.)

11536 TRACER TECHNIQUES. Seaman, William (American Cyanamid Co., Bound Brook, N. J.). pp 5513-81 of Treatise on Analytical Chemistry. Vol. 9, Pt. I. /Kolthoff, I. M. (ed.). New York; John Wiley and Sons, Inc. (1971).

Types of tracer methods, their capabilities, and their limitations are discussed. Other topics include: requirements for tracers and labeled compounds and their preparation; indicator analysis; isotope dilution; and, analysis with radioactive reagents (radiometric analysis). (165 references.) (J.G.B.)

11537 SPECIFICATION FOR COUNTING TRAYS (PLANCHETS) FOR RADIOACTIVE ASSAY. BS 3775 1964. London; British Standards Institution (1964). 6p. Available from American National Standards Institute, New York.

Counting trays (planchets) manufactured from aluminum, platinum, tantalum, and stainless steel and intended for the mounting of specimens for radioactive assay are described. (M.C.G.)

11538 DIRECT DETERMINATION OF URANIUM IN THE PRESENCE OF n-TRIBUTYL PHOSPHATE BY THE METHOD OF BACKSCATTERED β-RADIATIONS. Marcu, Gheorghe; Tolea, Florian; Duca, Ioan. Stud. Univ. Babes–Bolyai, Ser. Chem.; 16: No. 1, 149-51(1971). (In Rumanian).

The possibility of directly determining uranium as the uranyl salt in the presence of an organic solvent (n-tributyl phosphate) was established for the first time by the method of β backscattering. The method can be applied to systems containing at least 0.825 g U/l with a medium error of 0.8%. It is rapid and can be automated so that it should allow following the concentration of the solutions of uranyl in industrial installations. The method can be applied both for processing the concentrates rich in uranium used to prepare uranium necessary for the nuclear industry, and for recovering it from the solutions resulting from processing the nuclear fuels. (auth)

11539 USE OF β-BACKSCATTERING OF DETERMINATION OF THE RELATIVE CONCENTRATION IN THE SEPARATION OF UO_2^{2+} OF SOME ATTENDANT ELEMENTS ON A MICROCOLUMN WITH THE CS-3 CATION EXCHANGER. Ripan, Raluga; Sacelean, V.; Pascu, N. (Chemische Institut, Cluj). Rev. Roum. Chim.; 16: No. 8, 1193-6(Aug 1971). (In German).

The possibility of the use of β-backscattering for determination of the relative concentrations of elements such as Cd, Pb, and Bi in a drop in the separation of binary UO_2^{2+}–M^{n+} systems by ion exchange was investigated. (M.C.G.)

11540 USE OF β-BACKSCATTERING FOR THE ELEMENTAL ANALYSIS OF GASES. Nikol'skii, V. S. (Inst. of Chemical Physics, Noginsk, USSR). Zh. Anal. Khim.; 26: No. 11, 2240-3 (Nov 1971). (In Russian).

An experimental method was developed, which permits recording electrons emitted by radioisotopes and scattered by gas atoms

by means of a Geiger counter. The additivity and isocharging of the scattering signal were proved experimentally. The experimental ratios of the scattering sections were obtained for the following gases: H_2, He, N_2, O_2, Ar, CD_4, and C_2H_2. On the basis of the experimental results the minimum measurable amounts of impurities were determined. At a ratio of the signal to the noise equal to 2 they are 0.1% vol of Ar in He and 0.3% vol of N_2 in He. The measuring time is 10^2 sec. (auth)

11541 PECULIARITY OF THE USE OF β BACKSCATTERING FOR DETERMINING THE ELEMENTAL COMPOSITION OF LIQUIDS. Nikol'skii, V. S. (Inst. of Chemical Physics, Noginsk, USSR). Zh. Anal. Khim.; 26: No. 11, 2188-94(Nov 1971). (In Russian).

Isocharging of the coefficient of the backscattering of electrons η from complex substances was substantiated theoretically and proved experimentally. Effective charge of the target material for the compound B_mC_n can be calculated by the formula $Z_{ef} = (mZ_B^2 + nZ_C^2/mZ_B + nZ_C)$. The relationship $\eta = \eta (Z_{eff})$, which is derived by means of β particles does not depend, within 20%, on the angle of descent ($\leq 30°$) and the angle of recording ($\leq 30°$) reflected electrons in the case of recording backscattered electrons with values of energy more than 0.3 from the initial ones. (auth)

Activation Procedures

Refer also to abstracts 11951, 11967, 12174, 12198, 12199, 12206–12208, 12214, 12363–12367, 13115, 13914–13916, 14538, and 14582.

11542 (CONF-710402–(Vol.1), pp II.37-44) USES OF NEUTRONS IN FORENSIC SCIENCE. Guinn, Vincent P. (California Univ., Irvine). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Owing to its tremendous sensitivity for the detection and quantitative measurement of a large number of the chemical elements, its multi-element instrumental analysis capability, and the nondestructive character of the instrumental form of the method, high-flux thermal-neutron activation analysis (NAA) is finding steadily increasing usage in the field of crime investigation. Five laboratories in the world (three in the U. S., one in Canada, one in England) currently use NAA regularly in the investigation of criminal cases. In the United States, Canada, and England, altogether, the method has now been used in the investigation of approximately 2,000 cases, and NAA results have been presented in court in approximately 200 of the cases. Large-scale basic studies have been carried out on six kinds of evidence materials: human head hair, gunshot residues, paint, bullet lead, crude oils and fuel oils, and bond paper. (auth)

11543 (CONF-710402–(Vol.1), pp III.39-46) USES OF NEUTRON SOURCES IN POLLUTION CONTROL. Leddicotte, G. W. (Georgia Inst. of Tech., Atlanta). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The application of activation analysis with neutron sources to problems related to environmental pollution is growing steadily. The application of neutron sources and activation analysis to the identification and measurement of pollutant materials in our natural environment is reviewed. (auth)

11544 (CONF-710402–(Vol.1), pp V.7-13) IN VIVO HUMAN CALCIUM MEASUREMENTS USING PLUTONIUM–BERYLLIUM SOURCES. McNeill, Kenneth G.; Harrison, Joan E.; Cabeza, Luis (Toronto Univ. (Ontario)). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Plutonium–beryllium sources are being used at Toronto for the in vivo neutron activation analysis of the calcium content of the human body. The 0.2% isotope ^{48}Ca is activated to 9-min ^{49}Ca, which emits a 3.1-MeV gamma ray. The irradiation facility consists of twelve 5 curie sources that are symmetrically placed above and below the trunk of the subject. After irradiation for two half-lives, the subject is quickly (3 min) transferred to the Whole Body Counter of the Toronto General Hospital. The detecting system there consists of four 8 inch by 4 inch NaI crystals. A 20-minute count is taken of the subject. The ^{49}Ca peak is well separated from the neighboring ^{24}Na peak. Using a skeletal phantom, a total of about 1100 counts was obtained in the ^{49}Ca photopeak, which will permit a ±5% accuracy on measurements of calcium content. (auth)

11545 (INR-P-1310) DETERMINATION OF OXYGEN IN STEELS BY 14-MeV NEUTRON ACTIVATION ANALYSIS. Sterlinski, Slawomir; Golian, Cezary (Institute of Nuclear Research, Warsaw (Poland)). 1971. 40p. (In Polish). Dep. NTIS (U. S. Sales Only).

The nuclear reaction $^{16}O(n,p)^{16}N$ for the determination of oxygen in steels was utilized. Steel samples were transferred by means of the one-way pneumatic system. To achieve isotropic irradiation the technique of spinning samples during activation was used. The irradiation, transfer, and counting sequence may be automatically controlled. For normalization of the sample activation the standard fast-neutron-monitoring system was applied. An ordinary, cylindrical 3" × 3" NaI(Tl) scintillation detector was used for the counting. The limit of oxygen detection for a 15-g steel sample is 10 ppM, and the limit of determination 55 ppM. The relative standard deviation amounted to 30, 10, and 6% for the oxygen concentration levels of 10, 100, and 4000 ppM, respectively; "apparatus error" is equal to 5.5%. Typical analysis of the sample containing about 100 ppM of oxygen requires approximately 2 minutes of experimental time. (auth)

11546 ELEMENTAL ANALYSIS IN NORMAL AND CATARACTOUS HUMAN LENS TISSUE. Swanson, Arnold A.; Truescale, Ann W. (Medical Univ. of South Carolina, Charleston). Biochem. Biophys. Res. Commun.; 45: No. 6, 1488-96(17 Dec 1971).

Neutron activation analysis was used for the determination of Br, Cd, Cl, Co, Cu, Fe, Ir, K, La, Mg, Mn, Mo, Na, Sb, Se, and Zn in combined lens capsule and epithelium, cortex and nucleus. This study represents the first attempt in evaluating 17 elements at their concentration levels in lens tissue fractions at different age levels. Normal human lenses ranged in age groups from 0 to 5, 10 to 20, 50 to 60, and 70 to 85 years. For cataractous lenses, age groups 40 to 55, 60 to 75, and 80 years and over were studied. Essential elements were found to decrease with age and cataractogenesis. Suspected elements of biological function gave variable results, whereas nonessential elements increased with age and in cataractogenesis. (auth)

11547 ACTIVATION ANALYSIS OF ATMOSPHERIC POLLUTANTS. Mamuro, Tetsuo (Radiation Center of Osaka Prefecture, Sakai, Japan). Genshiryoku Kogyo; 17: No. 8, 19-25 (Aug 1971). (In Japanese).

Review is made on activation analysis with instruments, application of the analysis, and fluorescence x-ray analysis of energy dispersion type. Elements present in dust in the atmosphere are determined by activation analysis. Results of the activation analysis of polluted river water are explained in detail. Various elements including Na, Al, Cl, K, Ca, Sc, Cr, Mn, Fe, Co, and Zn were determined in the Yodo River district, where industrialization is rapidly progressing. γ Spectrometers which make use of Ge(Li) semiconductor detectors and multichannel wave height analyzers are very useful for determination of many nuclides including Al, V, Ti, Ca, Cl, In, Mn, K, Zn, and Na present in the dust floating in the air. Analysis of spectra obtained is made with electronic computers. Results of analysis of the air dust for a month in 1970 at four definite locations were given as examples. (Japan)

11548 DETERMINATION OF TRACE ELEMENTS IN TEA PLANT BY NEUTRON ACTIVATION ANALYSIS. Takeo, Tadakazu (Tea Research Station, Kanaya, Japan); Shibuya, Masao. Chagyo Gijutsu Kenkyu; No. 42, 58-63(Mar 1971). (In Japanese).

Mn, Cu, Na, K, Br, and Zn in tea plants were determined by nondestructive activation analysis, using a Ge(Li) gamma spectrometer. The levels of each elemental content showed the characteristic differences between part of the tea shoot or the tea vegetative cutting and the tea root collected at an interval of two or four months. Some parts of Mn and Cu were recognized in chloroplast, mitochondria and soluble protein in the supernatant after centrifuging at 12,000 rpm, and most of the Na and K appeared in the non-protein fraction of the supernatant. As the characteristics of the elemental contents in Japanese tea, it was indicated that the levels of the Na content in green tea and the Cu content in black tea were higher than that of the imported teas. (auth) (Japan)

11549 SEARCH FOR INTERNAL ISOTOPIC TRACERS IN METALLURGICAL MATERIALS. II. THE DETERMINATION OF W, As, Au, La, In, Sc, Re, Ir, AND Ta IN METALLURGICAL MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Jaskolska, H.; Rowinska, L.; Radwan, M. (Inst. of Nuclear Research, Warsaw). J. Radioanal. Chem.; 8: No. 2, 235-42(Aug 1971).

On the basis of results obtained it can be concluded that none of the examined elements could be used as an internal tracer for studying processes that take place during production of steel in chosen steel-works. However, some of the examined elements could be used as inactive tracers. The results of the determination of lanthanum are particularly interesting in view of the fact

that this element was used as inactive tracer for examination of the origin of exogenic inclusions. (auth)

11550 SIMULTANEOUS SEPARATION OF ^{11}C AND ^{13}N BY OXIDIZING FUSION FOR THE PURPOSE OF THE DETERMINATION OF TWO LIGHT ELEMENTS BY A SINGLE ACTIVATION BY γ PHOTONS OR CHARGED PARTICLES. Marschal, A.; Gosset, J.; Engelmann, Ch. (CEN de Saclay, Gif-sur-Yvette, France). J. Radioanal. Chem.; 8: No. 2, 243-55(Aug 1971). (In French).

A method of simultaneous ^{11}C and ^{13}N separation by oxidizing fusion is described. It can be used in particular to determine, from a single irradiation with γ photons or charged particles (p, d, ^3He, or α), two light elements amongst traces of Be, B, C, N, and O in certain highly pure metals and semiconducting materials. (auth)

11551 ISOTOPE CATALOGUE FOR INSTRUMENTAL ACTIVATION ANALYSIS. II. Pagden, I. M. H.; Pearson, G. J.; Bewers, J. M. (Bedford Inst., Dartmouth, Nova Scotia). J. Radioanal. Chem.; 8: No. 2, 373-479(Aug 1971).

11552 ACTIVATION ANALYSIS OF HIGH-PURITY SILICON. I. DETERMINATION OF PHOSPHORUS. De Corte, F.; Speecke, A.; Hoste, J. (Univ., Ghent). J. Radioanal. Chem.; 8: No. 2, 277-85(Aug 1971).

^{32}P was separated from the irradiated silicon matrix as ammonium phosphomolybdate and the activity was measured with a GM tube or on a plastic scintillator. The second-order interference was taken into consideration. (auth)

11553 STUDY OF THE POSSIBILITIES OF DETERMINING LITHIUM BY ACTIVATION BY MEANS OF PROTONS AND DEUTERONS OF MEDIUM ENERGY. Vialatte, B. (CEN de Saclay, Gif-sur-Yvette, France). J. Radioanal. Chem.; 8: No. 2, 269-76(Aug 1971). (In French).

The determination of lithium by measuring ^7Be, produced by proton or deuteron activation, was studied. The extent of interference from boron or beryllium, which also form ^7Be, was measured. The calculated sensitivity limits when activating for one hour with 10 μA beams of 14-MeV protons or 25-MeV deuterons are, for lithium, 1×10^{-1} and 2.5×10^{-2} ppM and for boron, 2×10^{-1} and 1×10^{-1} ppM, respectively. (auth)

11554 OPTIMISATION OF CELL DESIGN FOR ACTIVATION ANALYSIS OF FLOWING SYSTEMS. Boswell, C. R. (Massey Univ., Palmerston North, N. Z.). J. Radioanal. Chem.; 8: No. 2, 345-55(Aug 1971).

A theoretical relationship between the half-life and activity of a radioisotope produced by neutron activation of a flowing system, the flow rate, and the irradiation, delay, and counting volumes was developed. An expression was then obtained for the flow rate producing maximum activity of the radioisotope. Both expressions were solved using a digital computer for a variety of half-lives, activities, and combinations of irradiation, delay, and counting volumes. It is shown that, for any given system, the activity as a product of the half-life and corresponding flow rate is independent of the half-life. (auth)

11555 ACTIVATION ANALYSIS OF HIGH-PURITY SILICON. II. MULTI-ELEMENT ANALYSIS: SEPARATION SCHEME FOR 21 ELEMENTS. De Corte, F.; Speecke, A.; Hoste, J. (Univ., Ghent). J. Radioanal. Chem.; 8: No. 2, 287-301(Aug 1971).

A method for simultaneous determination of 21 elements in high-purity silicon was developed by activation analysis. Extraction, ion exchange, distillation and precipitation techniques were used combined with NaI(Tl) and Ge(Li) γ spectrometry. Attention was paid to the separation time, sensitivity, and selectivity of the method. (auth)

11556 COINCIDENCE LOSSES IN ACTIVATION ANALYSIS. Wyttenbach, A. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). J. Radioanal. Chem.; 8: No. 2, 335-43(Aug 1971).

Coincidence losses may introduce a considerable error in γ spectrometry and are thus a serious potential source of inaccurate activation analysis. A simple first order correction for coincidence losses can be applied by measuring the counting interval in both the true-time and in the live-time modes; the proposed equation is shown by two experiments to hold up to an integral count rate of at least 4×10^4 cps. (auth)

11557 OXYGEN DETERMINATION BY FAST NEUTRON ACTIVATION. Lisovskii, I. P.; Smakhtin, L. A. (Inst. of Physical Chemistry, Moscow). J. Radioanal. Chem.; 8: No. 2, 321-4(Aug 1971).

A method for determination of oxygen based on the reaction $^{16}O(n,p)^{16}N$ is suggested. The samples are irradiated in stainless steel capsules with fast neutrons. The total neutron flux passing through the sample is proportional to the flux passing through the wall of the capsule. Therefore, the activity induced in the capsule according to the reaction $^{56}Fe(n,p)^{56}Mn$ can be used to monitor the neutron flux through the sample. Thus, the necessity of maintaining the sample in an exact position during the irradiation is eliminated. (auth)

11558 SIMULTANEOUS NON-DESTRUCTIVE DETERMINATION OF Al, Si, AND K IN TUNGSTEN WITH 14 MeV NEUTRONS. Vass, Sz. (Central Research Inst. for Physics, Budapest); Vorsatz, B.; Szabo, E.; (and others). J. Radioanal. Chem.; 8: No. 2, 325-34(Aug 1971).

A nondestructive simultaneous method was developed for the rapid determination of Al, Si, and K in WO_3 powders and W metal powders. The samples were activated by 14-MeV neutrons and the radioactive isotopes identified by their γ spectra with a 3″ × 3″ NaI(Tl) detector. Quantitative analysis was carried out by measuring the full energy peak areas. The determined concentrations of Al, Si, and K were above 100, 100, and 500 ppM, the sensitivities being about 20, 10, and 100 ppM, respectively. (auth)

11559 GASEOUS BROMINE AND PARTICULATE LEAD, VANADIUM, AND BROMINE IN A POLLUTED ATMOSPHERE. Moyers, Jarvis L.; Zoller, William H.; Duce, Robert A.; Hoffman, Gerald L. (Univ. of Hawaii, Honolulu). Environ. Sci. Technol.; 6: No. 1, 68-71(Jan 1972).

Atmospheric gaseous bromine and particulate lead, vanadium, and bromine were collected simultaneously in Cambridge, Mass., with activated charcoal and membrane filters. This study showed a significant fraction of bromine in the polluted atmosphere exists in the gaseous phase. Concentrations of gaseous bromine ranged from 0.12 to 0.45 $\mu g/m^3$; particulate bromine, 0.12 to 0.94 $\mu g/m^3$; and particulate vanadium, 0.08 to 1.32 $\mu g/m^3$ as determined by neutron activation analysis. Lead concentrations varied from 0.4 to 3.7 $\mu g/m^3$ as determined by atomic absorption spectroscopy. All particulate species showed significant correlation with each other, indicating that their interrelationships in the atmosphere can be explained largely by meteorological conditions. However, the correlation of Pb with both particulate Br and total Br was exceptionally good since Pb and Br come from the same source. Despite this, results indicate the atmospheric concentrations of Br are less than suspected from the amounts of Br added to gasoline in ethyl fluid. The lower atmospheric Br concentration may be explained by different residence times for Br and Pb or that some Br exists in a chemical form not collected by filtration or activated charcoal adsorption. (auth)

11560 PROTON ACTIVATION ANALYSIS FOR TRACE ELEMENTS. Fiarman, Sidney; Schneier, Gary (Univ. of Kansas, Lawrence). Environ. Sci. Technol.; 6: No. 1, 79-81(Jan 1972).

Trace element concentrations in water samples were determined from analysis of γ spectra produced by bombarding the samples with a 4-MeV proton beam from a Van de Graaff accelerator. Concentration levels in the parts per billion range for most light elements $Z \geq 25$ appear to be detectable. Some measured representative values are: P, 28, ppB; N, 190 ppB; S, 37 ppB; F and Na, 0.1 to 1.0 ppB. (auth)

11561 NOBLE METAL DETERMINATION IN METEORITES. Gillum, David E.; Ehmann, William D. (Univ. of Kentucky, Lexington). Contract AT(40-1)-2670. Radiochim. Acta; 16: No. 3-4, 123-8(Dec 1971).

A relatively simple and rapid analytical scheme was developed for the determination of gold, platinum, iridium, ruthenium, silver, cobalt, and nickel in small samples of geochemical interest. The determinations are based on thermal neutron activation followed by gamma–gamma coincidence spectrometry and rapid radiochemical separations. The procedures developed were used for the simultaneous determination of these elements in meteorite samples. (auth)

11562 METHOD AND DEVICE FOR THE NON-DESTRUCTIVE ANALYSIS OF NUCLEAR FUELS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,252,230. 3 Nov 1971. Priority date 31 Oct 1969, Germany.

A method for nondestructive analysis of nuclear fuels for use in a safeguards system is described. A neutron beam of a predetermined energy distribution as the primary radiation is directed at the nuclear fuel to be analyzed, completely penetrates it, and, as a result of nuclear reactions, generates secondary radiation that reaches at least a space immediately surrounding the fuel and is measured. (M.C.G.)

11563 ACTIVATION METHOD FOR DETERMINING CHEMICAL YIELDS IN ANALYTICAL SEPARATIONS. Rakovic, M.; Glagolicova, A.; Prouza, Z. (Charles Univ., Prague). Radiochem. Radioanal. Lett.; 8: No. 6, 371-5(31 Dec 1971).

A method for the simultaneous determination of chemical yields of several elements is proposed, based on preparing and activating standards of elements of interest and comparing photopeak (annihilation peak) areas determined prior to the separation with those obtained after the separation. (auth)

11564 MERCURY IN THE HAIR OF ROBERT BURNS. Lenihan, J. M. A.; Leslie, A. C. D.; Smith, H. (Western Regional Hospital Board, Glasgow). Lancet; 2: No. 7732, 1030 (6 Nov 1971).

Activation analysis was used to determine mercury in a sample of Burns's hair. The mercury content was 8.02 ppM. The results are briefly compared with contemporary levels in British adults. (UK)

11565 N-BENZOYL-N-PHENYLHYDROXYLAMINE AS A SUBSTOICHIOMETRIC EXTRACTANT IN NEUTRON ACTIVATION ANALYSIS. I. DETERMINATION OF SCANDIUM IN ROCKS. Nadkarni, R. A.; Haldar, B. C. (Inst. of Science, Bombay). Radiochem. Radioanal. Lett.; 8: No. 6, 341-8(31 Dec 1971).

Trace amounts of scandium were determined in five standard rocks and one meteorite by thermal neutron activation followed by substoichiometric extraction with N-benzoyl-N-phenylhydroxylamine (BPHA). The Sc–BPHA complex (1 : 3) is extracted into isoamyl alcohol at pH 3.7 to 6.0. Two samples with one standard can be analyzed in less than 1 hr. (auth)

11566 BLANK VALUE IN 14 MeV NEUTRON ACTIVATION ANALYSIS OF NITROGEN IN SAMPLES CONTAINING HYDROGEN AND OXYGEN. Geisler, M.; Maul, E.; Panse, H. (Zentralinstitut fuer Isotopen- und Strahlenforschung, Leipzig). Radiochem. Radioanal. Lett.; 8: No. 6, 349-55(31 Dec 1971).

In the determination of nitrogen by the reaction $^{14}N(n,2n)^{13}N$, the reactions $^{16}O(p,\alpha)^{13}N$, induced by recoil protons, imitate an apparent nitrogen content. This blank value was measured in 18 organic compounds and water and was found to come up to 0.67% $N(H_2O)$. The reaction $^{16}O(p,\alpha)^{13}N$ gives by far the highest amount, so that in practice it is possible to use a linear relation between the N blank value and the product of hydrogen and oxygen content. (auth)

11567 USE OF SHORT-LIVED NUCLIDES (T < 10 sec) FOR 14 MeV NEUTRON ACTIVATION ANALYSIS. Janczyszyn, J.; Loska, L.; Gorski, L. (Inst. of Nuclear Techniques, Krakow). Radiochem. Radioanal. Lett.; 8: No. 6, 363-70(31 Dec 1971).

An automatic activation analysis system for the measurement of short-lived nuclides was constructed and checked. Twenty nuclides with half-lives from 0.043 to 7.4 sec were activated and their spectra recorded using this system. A sensitivity table was prepared from which the possibility for the use of ^{197m}Au, ^{183m}W, ^{79m}Br, ^{167m}Er, ^{207m}Pb, ^{203m}Pb, $^{114m2}In$, ^{90m}Zr, ^{175m}Yb, and $^{114m3}In$ for 14-MeV, cyclic neutron activation analysis was established. (auth)

11568 ACTIVATION ANALYSIS. Guinn, Vincent P. (Univ. of California, Irvine). pp 5583-5641 of Treatise on Analytical Chemistry. Vol. 9, Pt. I. /Kolthoff, I. M. (ed.). New York; John Wiley and Sons, Inc. (1971).

The following topics are discussed: theory of activation analysis; particle sources and types of nuclear reactions; forms of the activation analysis method, including instrumental and radiochemical-separation forms; sensitivity of activation analysis for various elements; sources of error, accuracy, and precision; and applications of activation analysis. (J.G.B.)

11569 GROUP SEPARATION TECHNIQUES FOR THE DETERMINATION OF NOBLE METALS IN METEORITES BY ACTIVATION ANALYSIS. Gillum, David Eugene. Lexington, Ky.; Univ. of Kentucky (1971). 164p. University Microfilms Order No. 71-25,893.

Thesis.

A separation scheme was developed for determination of a series of noble metals in the same small geochemical sample. It was possible to determine iridium, cobalt, nickel, gold, platinum, silver, and ruthenium in a 100-mg meteorite sample. Iridium, cobalt, and nickel may be determined by nondestructive gamma-gamma coincidence counting, which avoids the problems associated with the radiochemical separation of iridium. Platinum was determined by counting ^{199}Au, which is the radioactive product from the β-decay of 30-min ^{199}Pt formed by the (n,γ) reaction on ^{198}Pt. This permits the determination of both gold and platinum while requiring the radiochemical separation of only one element (gold). A radiochemical separation for gold utilizing the technique of substoichiometric separation was developed. Gold was extracted with a 5×10^{-3} M solution of copper diethyldithiocarbamate in chloroform from a 1.5 M hydrochloric acid solution by shaking for 45 sec. Ruthenium was separated as the tetroxide by distillation from a sulfuric acid solution using sodium bromate as the oxidizing agent. After distillation, ruthenium was reduced to the metal with zinc. The radiochemical separation of silver was carried out by a rapid ion exchange procedure with Dowex 1-X8 resin. Replicate analyses for gold and platinum were made on 39 selected chondritic meteorite samples. Replicate analyses for silver and ruthenium were made on 11 and 8 selected meteorites, respectively. Gold and platinum were found to be positively correlated in all meteorites analyzed. These elements were also correlated with the metal phase content of the ordinary chondrites. (Diss. Abstr. Int., B)

11570 DISTRIBUTION OF COBALT BETWEEN COEXISTING BIOTITE AND HORNBLENDE IN IGNEOUS ROCKS. Greenland, L. Paul; Tilling, Robert I.; Gottfied, David. Neues Jahrb. Mineral., Monatsh; No. 1, 33-62(1971).

Cobalt was determined by neutron activation in 95 pairs of coexisting biotite and hornblende from igneous rocks ranging in composition from gabbro to syenite. The distribution ratio of Co in hornblende to Co in biotite averages 0.66 with a standard deviation of 0.13. The distribution coefficient apparently is unaffected by initial crystallization temperature, cooling history, or major element composition of the minerals or magmas. Partition of Co between biotite and hornblende appears to provide a useful estimate of the degree of equilibrium attained by a given rock system but has no potential application as a geothermometer. (Abstr. of N. Amer. Geo.)

11571 DETERMINATION OF TRACE ELEMENTS IN TEA AND COFFEE BY NEUTRON ACTIVATION ANALYSIS. Shah, Kishor R.; Filby, Royston H.; Davis, Albert I. (Washington State Univ., Pullman). Int. J. Environ. Anal. Chem.; 1: No. 1, 63-73 (Aug 1971).

Thermal neutron activation analysis, a high-resolution Ge(Li) gamma spectrometer, and an IBM 360/67 digital computer were used to determine the concentration of Na, K, Sc, Cr, Mn, Fe, Co, Cu, Zn, Se, Br, Rb, Sb, Cs, and Hg in ground coffee and tea. This nondestructive multielement technique requires neither pre nor postirradiation chemistry and eliminates problems of reagent contamination. The method is simple, precise, and sensitive to 15 elements. Interferences from fast neutron (n,p) and (n,α) reactions are small and, if necessary, corrections may be applied easily. This technique can be applied to percolated tea and coffee. (auth)

11572 IMPROVED PROTON ACTIVATION ANALYSIS FOR OXYGEN DIFFUSION. Robin, Rene Christophe. Cleveland; Case Western Reserve Univ. (1971). 180p. University Microfilms Order No. 71-22,843.

Thesis.

^{18}O diffusion coefficients were measured directly and without the combined need for serial sectioning, using proton activation analysis for ^{18}O via the nuclear reaction $^{18}O(p,\alpha)^{15}N$. The alpha particle spectrum recorded during proton irradiation is used to determine the ^{18}O concentration profile with a sub-micron resolution. A detailed analysis of the technique is presented. The feasibility of this approach was demonstrated by studying oxygen self-diffusion in zinc oxide single crystals. Using a convolution procedure, the oxygen self-diffusion coefficients, D, could be determined with a relative uncertainty below 20%; the technique is optimum for determining D in the range 5×10^{-12} to 4×10^{-17} cm^2/sec. The technique also proved useful for testing diffusion models. Analysis of the data suggested that the diffusion was partly controlled by a surface exchange reaction of oxygen described by a first order parameter constant K. In the temperature range (940 to 1140°C), D followed the relation: $D = 1.5\ (^{+1.5}_{-0.9}) \times 10^{-10}$ exp $(-30.5 \pm 3$ Kcal/RT) (cm^2/sec), which is attributed to extrinsic diffusion. K could be determined in the range (940 to 1040°C) and could be described by $K = 10^5$ exp (– 87 Kcal/RT) (cm/sec). (Diss. Abstr. Int., B)

11573 THEORY OF COMPONENT SELECTION IN ACTIVATION ANALYSIS. Zinov'ev, N. V. At. Energ. (USSR); 31: No. 5, 525-6(Nov 1971). (In Russian).

A simplified version of the algorithm used to handle the calculation and interpretation of activation analysis data is presented. The new algorithm is not absolute, since the component forms are unorthogonal, but may be successfully employed as a program in instrumental activation analysis. (K.S.W.)

11574 OPTIMIZATION OF ACTIVATION MEASUREMENTS. Vozzhenikov, G. S. At. Energ. (USSR); 31: No. 5, 526-7(Nov 1971). (In Russian).

The total time consumed in irradiating a target and recording the induced activity is minimal, enabling the process of activation measurements to be optimized. The optimal activation time was designed for an exponential decrease in activity with respect to time. A nomogram is presented for determining the optimal duration of activation. (K.S.W.)

11575 QUANTITATIVE ANALYSIS OF SIXTEEN ELEMENTS IN NORMAL HUMAN ENAMEL AND DENTINE BY NEUTRON ACTIVATION ANALYSIS AND HIGH-RESOLUTION GAMMA-SPECTROMETRY. Retief, D. H. (Univ. of the Witwatersrand, Johannesburg. South African Medical Research Council, Johannesburg); Cleaton-Jones, P. E.; Turkstra, J.; De Wet, W. J. Arch. Oral Biol.; 16: No. 11, 1257-67(Nov 1971).

The sample to be analysed and a standard of known composition were irradiated simultaneously in the SAFARI I reactor and the induced radioactivity compared. The investigation was done with high resolution Ge(Li) detectors coupled to fully transistorized 400 and 4000 channel analysers. By varying the irradiation time and conditions, it was possible to employ a nondestructive analytical procedure. The concentration of 16 elements, namely, Mg, Na, Cl, Al, Ca, Cr, Ba, Sb, Ag, Zn, Co, Fe, Sr, Au, Br, and Mn was determined in normal human enamel and dentine by instrumental activation analysis. (auth)

11576 ACTIVATION ANALYSIS OF GEOLOGICAL MATERIALS. Brunfelt, A.; Steinnes, E. (Univ. of Oslo). Kjemi; 31: No. 9, 13-16(11 Nov 1971). (In Norwegian).

The advantages of and background for activation analysis of geological materials are stated. The general principles of instrumental and radiochemical activation analysis are described with examples. The applications of scintillation detectors and semiconductor detectors are compared. Finally, the applications of on-line digital computers in activation analysis are briefly described. (Norway)

11577 USE OF COLLIMATED BEAMS OF EPITHERMAL AND FAST NEUTRONS IN IN VIVO ACTIVATION ANALYSIS. Boddy, K. (Scottish Research Reactor Centre, East Kilbride). 2p of Symposium on the Use of Cyclotrons in Medicine. London; Medical Research Council (1969).

From Symposium on the use of cyclotrons in medicine; London, England (20 Sep 1969). See CONF-690979.

Experiments are briefly described in which the intrathyroidal iodine was measured. Measurements with phantoms showed the reproducibility in measuring calcium in sections of bone will be of the order of 1% (standard deviation) with a dose of about 1 rem. Determinations of calcium in beef, pork, and mutton bone gave results in agreement with chemical analysis and atomic absorption spectrophotometry. The possibility of measuring simultaneously the magnesium content is mentioned, together with "total body" in vivo activation analysis. (UK)

Inorganic, Organic, and Physical Chemistry

Chemical Properties

Refer also to abstracts 11895 and 14497.

11578 INVESTIGATION OF THE COMPLEX FORMATION OF TRIVALENT ACTINIDE AND LANTHANIDE ELEMENTS BY THE METHOD OF ELECTROMIGRATION. XVIII. HYDRAZINE-IMINODIACETIC ACID. Levakov, B. I.; Shalinets, A. B. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 301-2(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 295-7(Mar-Apr 1971).

The complex formation of Am(III), Cm(III), and Ce(III) with hydrazineiminodiacetic acid (HDA) was studied. Stability constants were calculated and results indicated participation of the NH_2 group in coordination. (M.C.G.)

11579 FLUORINATION OF METALLIC URANIUM BY CERTAIN FLUORIDE SALTS. Khripin, L. A.; Luk'yanova, L. A. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 303-5(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 297-9(Mar-Apr 1971).

A method was developed for synthesizing uranium trifluoride, based on the oxidative fluorination of metallic uranium by "mild" fluorinating agents. Pure anhydrous NaF, CuF_2, ZnF_2, CdF_2, MnF_2, NiF_2, CoF_2, PbF_2, AlF_3, and BiF_3 were used as fluorinating agents. The fluorinating agent was reduced to free metal in all reactions. The samples were analyzed and the phase composition determined. In most reactions UF_3 of satisfactory purity was obtained, containing 93 to 97% UF_3. (M.C.G.)

11580 STANDARD ENTHALPY OF FORMATION OF THE AMORPHOUS MODIFICATION OF URANIUM TRIOXIDE. Vidavskii, L. M.; Ippolitova, E. A. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 306-8(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 299-301(Mar-Apr 1971).

Amorphous and the crystalline γ-modification of UO_3 were studied. The enthalpy of the reaction of UO_3 with HF was measured by a calorimetric method. This permitted calculation of the enthalpy of crystallization, as well as the standard enthalpy of formation of amorphous UO_3 (-292.26 ± 1.86 kcal/mole). (M.C.G.)

11581 HEXATHIOCYANATOCHROMATES OF URANIUM(III) WITH ANTIPYRINE, AMIDOPYRINE, PYRIDINE, AND DIMETHYLFORMAMIDE. Vyatkina, A. S.; Serebrennikov, V. V. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 309-10(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 301-2(Mar-Apr 1971).

Complexes of uranium(III) with the composition $[UAnt_6][Cr(SCN)_6]$, $[UAmp_3][Cr(SCN)_6]$, $[UPy_6][Cr(SCN)_6]$, $[UDmf_6][Cr(SCN)_6]$ were produced, and their density and solubility in water at 25° were determined. (auth)

11582 PHYSICOCHEMICAL INTERPRETATION OF THE ABSOLUTE ZERO ACTIVITY COEFFICIENTS AND EXTRACTION CONSTANTS OF ELECTROLYTES. Rozen, A. M.; Ionin, M. V. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 290-2(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 287-9(Mar-Apr 1971).

It was shown that the absolute zero activity coefficients represent the dissociation constants of electrolytes in solution. The thermodynamic extraction equilibrium constant was determined by the ratio of the dissociation constants of the molecules of the electrolytes in the organic and aqueous phases. The values of the zero activity coefficients of certain electrolytes, including uranyl ions, in aqueous media were calculated. (auth)

11583 CORRELATION OF THE SOLUBILITY PRODUCTS OF ACTINIDE COMPOUNDS WITH THE PROPERTIES OF THE METAL IONS AND ACID ANIONS FORMING THEM. Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 299-300(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 293-5(Mar-Apr 1971).

The parameters of the correlation functions establishing the dependences of the solubility products of the actinide compounds on the properties of the metal ions and acid anions forming them were found. The deviation from the ratio of the ionic potentials φ_i/φ_j can apparently be considered as a quantitative characteristic of the effect of the extrastabilization by the ligand field for ions of the actinide elements. It was established that the correction for the effect of extrastabilization depends on the charge, structure, and nature of the ions participating in the correlation. (auth)

11584 METHOD OF PRODUCTION OF $UO_2(NO_3)_2.2NO_2$. Afanas'ev, Yu. A.; Tsubanov, V. G.; Ryabinin, A. I. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 321-2(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 311-12(Mar-Apr 1971).

To produce $UO_2(NO_3)_2 \cdot 2NO_2$, uranyl nitrate crystal hydrate was dissolved in TBP to saturation. The organic phase was separated from the aqueous phase, centrifuged, and separated once again. The TBP phase was treated with anhydrous nitric acid and intensive separation of a fine crystalline precipitate was observed. It was identified as $UO_2(NO_3)_2 \cdot 2NO_2$. (M.C.G.)

11585 STUDY OF THE STATE OF ^{99}Tc AND ^{54}Mn IN DISTILLED AND SEA WATER. Tikhomirov, V. N.; Gromov, V. V. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 329-30(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 316-18(Mar-Apr 1971).

Chemical states of ^{99}Tc and ^{54}Mn in seawater and distilled water were studied. They did not change their initial state in seawater and did not form colloidal particles. (M.C.G.)

11586 INVESTIGATION OF THE COMPLEX FORMATION OF TRIVALENT PLUTONIUM, AMERICIUM, AND CURIUM IN

ACETATE SOLUTIONS BY THE ION EXCHANGE METHOD. Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 220-3(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 221-3(Mar-Apr 1971).

The complex formation of trivalent plutonium, americium, and curium in acetate solutions was studied by the method of ion exchange. It was established that under the investigated experimental conditions, Pu^{3+} and Am^{3+} form acetate complexes with a M : ligand ratio varying successively from 1 to 6, whereas for Cm^{3+} this ratio varies from 1 to 4. The concentration (at μ 0.5 and 1.0) stability constants of acetate complexes of Pu^{3+}, Am^{3+}, and Cm^{3+} were calculated. (auth)

11587 INVESTIGATION OF THE COMPLEX FORMATION OF TRIVALENT PLUTONIUM AND AMERICIUM IN ACETATE SOLUTIONS BY A POTENTIOMETRIC METHOD. Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 224-9(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 224-30(Mar-Apr 1971).

The complex formation of trivalent plutonium and americium in acetate solutions was studied by the method of potentiometry. Pu(III) and Am(III) form acetate complexes, under the experimental conditions investigated, with a M : ligand ratio varying successively from 1 to 6. Using various methods of mathematical treatment of the experimental data, the concentration (at μ = 0.5 and 1.0) and thermodynamic stability constants of acetate complexes of Pu(III) and Am(III) were calculated. A definite pattern was detected in the composition of the acetate complexes of trivalent actinides formed, and an interpretation of it was given in the light of the modern concepts of the theory of the chemical bond in complex compounds. (auth)

11588 CORRELATION OF THE STABILITY CONSTANTS OF COMPLEXES OF THE ACTINIDES WITH THE PROPERTIES OF THE METAL IONS AND LIGAND FORMING THEM. Moskvin, A. I. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 230-7(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 230-8(Mar-Apr 1971).

The parameters a and b of the correlation ratios establishing the dependences of the stability constants of complexes of the actinides on the properties of the metal ions and anions of acids forming them (z, r, J_z, and EN) were found. It was shown that the deviation of the parameter a_{ij} from the ratio of the ionic potentials φ_i/φ_j is a quantitative characteristic of the effect of extra-stabilization by the ligand field for ions of the actinide elements. It was established that the value of t_{ij}, the correction for the effect of extra-stabilization, depends on the charge, the structure, and the nature of the ions participating in the correlation. (auth)

11589 PRODUCTION OF METHANE FOR USE IN NUCLEAR REACTORS. Crawley, Ralph Hugh Alfred; Stangret, Zdzislaw Ludwik (to British Nuclear Design and Construction Ltd.). British Patent 1,255,473. 1 Dec 1971. Filed 29 Nov 1967

A method is described for the on-site production of high-purity methane for use as a graphite–CO_2 reaction inhibitor in gas-cooled reactors. A mixture of H_2 and O_2 is produced electrolytically and means are provided for mixing the H_2 with CO_2 in the molecular ratio of at least 4 : 1. This mixture is passed over a suitable methanation catalyst bed and further mixing means are provided having a feed of O_2 and reactor coolant gas consisting essentially of CO_2 and CO; the mixture then passes to oxidation means for removing the bulk of the CO and H_2, and finally to drying means. The catalyst bed may comprise one or more reaction vessels having controlled heating and cooling means. The catalyst may comprise Ru on Al_2O_3. Various forms of reaction vessels are described. (UK)

11590 SELF-REDUCTION IN AMMONIUM URANATES. Price, G. H. (Australian Atomic Energy Commission, Sutherland). J. Inorg. Nucl. Chem.; 33: No. 12, 4085-92(Dec 1971).

The thermal decomposition of ammonium uranates (ADU) was studied by TGA, DTA, and the analysis of evolved gases and solid residues. It was shown that a significant amount of the contained ammonia is not expelled as gaseous ammonia on heating. That retained reduces the uranium oxide to approximately U_3O_8. This exothermic reaction is rapid at about 400°C. Water is evolved immediately but much of the nitrogen from the ammonia remains in the solid until substantially higher temperatures, when gaseous nitrogen is released. When ADU is reduced in hydrogen, self-reduction occurs as the first step. Some nitrogen is released but the UO_2 formed after complete reduction retains nitrogen which is not released in vacuum below 700°C. The degree of self-reduction is variable, drier heating conditions leading to greater self-reduction and lower temperatures of onset. (auth)

11591 EFFECT OF SOLVENTS ON ADDUCT FORMATION IN THE SCANDIUM–TTA CHELATE–TBP SYSTEM. Akiba, K.; Ishikawa, T.; Suzuki, N. (Tohoku Univ., Sendai). J. Inorg. Nucl. Chem.; 33: No. 12, 4161-70(Dec 1971).

Adduct formation was studied, between the thenoyltrifluoroacetone(TTA) chelate of scandium and tributyl phosphate (TBP), by a partition method. The formula for the adduct was found to be $ScA_3 \cdot S$ (where S is TBP), and no higher adducts such as $ScA_3 \cdot mS$ (m > 1) were formed. The formation constants were obtained in eleven organic solvents, and the effect of solvents on them was quantitatively explained in connection with the activity coefficients of the species involved. The formation constant in terms of the activity was evaluated at log K_s^0 = 2.95 and 3.03, from two approximate methods. The correlation was also established, between the formation constants of $ScA_3 \cdot S$ and those of $ZnA_2 \cdot S$. (auth)

11592 INTERACTION OF URANIUM(VI) WITH OXIDANTS IN ALKALINE MEDIA. Nemodruk, A. A.; Bezrogova, E. V.; Myasoedov, B. F. (Inst. of Geochemistry and Analytical Chemistry, Moscow). J. Radioanal. Chem.; 8: No. 2, 257-62(Aug 1971).

It was established that the violet-pink color that arises during sodium peruranate oxidation in strongly alkaline solutions and the black precipitate that is isolated during the aging of these solutions are not connected with the presence of uranium. Their formation is the result of a small amount of iron in the alkalies used; under the action of strong oxidants this is oxidized to Fe(VI), the compounds of which are intense violet-pink. (auth)

11593 CHEMICAL BEHAVIOR OF THE ^{72}As FORMED BY THE EC DECAY OF ^{72}Se IN AN ORGANIC SOLVENT. Sotobayashi, Takeshi; Suzuki, Toshio; Noda, Tomohiko (Niigata Univ., Japan). Bull. Chem. Soc. Jap.; 44: No. 6, 1711-12(Jun 1971).

Benzene and chloroform solutions of two selenium compounds with different chemical properties (selenocyanate complex and selenium tetrabromide) were prepared by a liquid–liquid extraction method, and the separation of ^{72}As from the solvent solutions and the oxidation state of the separated ^{72}As were studied. Approximately 75% of the ^{72}As recovered existed in the 3+ oxidation state, regardless of the difference in chemical nature of the extracted selenium compound. Results indicate that the effects of an electron capture (EC) decay process, followed by the bond rupture of the ^{72}Se-tagged compounds, probably play a major role in determining the deposition behavior ^{72}As. (J.G.B.)

11594 STUDY OF COMPLEXES WITH A POLYBASIC ACID. Am(III) CITRATE COMPLEXES. Ohyoshi, Emiko; Ohyoshi, Akira (Kumamoto Univ., Japan). J. Inorg. Nucl. Chem.; 33: No. 12, 4265-73(Dec 1971).

A method for study of complex formation by a polybasic acid was applied to the study of the Am(III) citrate complexes. The amount of free cation in equilibrium with the complexes was determined by an ion exchange method. At low pH, where the species H_3Cit^- and H_2Cit^{2-} both exist, a series of solutions containing a nearly constant amount of H_3Cit^-, with the H_2Cit^{2-} varied, was prepared. By using these solutions, it was found that complexes with H_2Cit^{2-}, AmH_3Cit^+, and $Am(H_2Cit)_2^-$ were formed while there was no evidence of complexes of the type, $Am(H_3Cit)_n$ even when the pH is less than 2. At a pH of 6.56, complexes with $HCit^{3-}$, AmHCit and $Am(HCit)_2^{3-}$ were found. The formation constants of the different complexes were determined. (auth)

11595 QUENCHING THE URANYL FLUORESCENCE BY AROMATIC MOLECULES. Matsushima, Ryoka; Sakuraba, Shukichi (Shizuoka Univ., Hamamatsu, Japan). J. Amer. Chem. Soc.; 93: No. 26, 7143-5(29 Dec 1971).

Quenching constants, K_q's, for the uranyl fluorescence quenching by aromatic molecules having widely different substituents were measured in aqueous acetone solutions at room temperature. The Stern–Volmer relationship was obtained between relative fluorescence intensity and the concentration of most of the aromatic quenchers. The rates decreased with the viscosity of the medium. A linear relationship was found between log K_q and $\sigma + 0.25(\sigma^+ - \sigma)$ of the substituents, with ρ values of –1.10 in aqueous 80% acetone and –0.83 in aqueous 10% acetone. A correlation was found between the rates of fluorescence quenching and the respective rates of nitration. The results suggest that the rate-determining step of the quenching process involves a π-complex formation between the excited uranyl ions and the quenchers. (auth)

11596 REDUCTION OF BROMINE(V) BY CERIUM(III), MANGANESE(II), AND NEPTUNIUM(V) IN AQUEOUS SULFURIC ACID. Thompson, Richard C. (Univ. of Missouri, Columbia). J. Amer. Chem. Soc.; 93: No. 26, 7315(29 Dec 1971).

Results are reported on the reduction of bromine(V) by Np(V) or a large excess of Ce(III) and Mn(II) in 3M sulfuric acid. The duration of the induction period increases with decreasing bromate concentration and temperature and increases in the order Np(V) < Mn(II) < Ce(III) for a given initial bromate concentration. After approximately 10% reaction the behavior of all three systems is accurately described by the empirical rate law $-d(BrO_3^-)/dt = k_1(BrO_3^-)^2$. (D.H.M.)

11597 S-[(N-TERPENOID CARBOXAMIDINIUM)METHYL] THIOSULFATES (BUNTE SALTS) AS POTENTIAL ANTIRADIATION AGENTS. Barton, Jerry M.; Bauer, Ludwig (Univ. of Illinois, Chicago). Can. J. Chem.; 47: 1233-7(1 Apr 1969).

The synthesis of a number of α-acetamidinium Bunte salts, substituted on one of the nitrogen atoms by a terpenoid moiety, is reported. The N-bornyl and N-(cis-myrtanyl) derivatives of S-[(N-substituted carboxamidinium)methyl] thiosulfates, $^-O_3SSCH_2C(=NH_2^+)NHR$, when administered orally or intraperitoneally 15 min prior to irradiation (800 to 1000 R, x rays) showed a high survival rate at one-half to one-quarter the toxic (LD_{50}) dosage. (auth)

11598 COMPLEXES OF ACTINIDES IN MOLTEN SALTS. Kertes, A. S. (Hebrew Univ., Jerusalem). Actinides Lanthanides Rev.; 1: No. 5, 371-407(Sep 1971).

Research on actinide complexing in molten salts has been mostly on thorium, uranium, and plutonium, almost exclusively in chloride and fluoride melts. Studies on absorption spectra, electrochemistry, phase equilibria, distribution and separation, effects of salt composition on complex formation, and complex species are discussed. (201 references). (M.C.G.)

11599 ELECTROCHEMICAL REDOX MECHANISM OF URANIUM IN ACIDIC PERCHLORATE SOLUTIONS. Sipos, L. (Center for Marine Research, Zagreb); Jeftic, L. J.; Branica, M.; Galus, Z. J. Electroanal. Chem. Interfacial Electrochem.; 32: No. 1, 35-47(Aug 1971).

The behavior of uranium in perchlorate media, on dropping mercury, hanging mercury drop, and thin-layer electrodes was studied. Attempts were made to explain the mechanism of the electrode reactions and to identify the ionic species formed at the electrode. Typical chronovoltammetric curves of uranium(VI) are presented. Under certain conditions the reduction of uranium(V) is influenced by the chemical reaction of U(V) with U(III). (M.C.G.)

11600 STRUCTURE AND CONFORMATION OF Th(IV)-COMPLEXES OF TRIETHYLENETETRAMINEHEXAACETIC ACID IN AQUEOUS SOLUTION. Fried, A. R. Jr.; Martell, A. E. (Texas A and M Univ., College Station). J. Coord. Chem.; 1: No. 1, 47-56(Aug 1971).

The aqueous (D_2O) infrared and proton NMR spectra of triethylenetetraminehexaacetic (TTHA) and the 1:1 Th(IV)–TTHA chelate were studied as a function of "a" value (a = moles of base/mole of ligand). With the aid of infrared and NMR data the specific successive protonation sites of the anion are described as a function of increasing hydrogen ion concentration. The NMR spectra of Th(IV)–TTHA indicate that with increasing alkalinity protonated species persist until a = 4(pD 1.47), where an extremely stable $[Th(IV)-TTHA]^{2-}$ chelate predominates. The NMR spectra of the Th(IV)–TTHA complex at a = 6 exhibit characteristic multiplet splitting patterns for the ligand geminal acetate protons, indicating environmental non-equivalence of the ligand atoms. A ten-coordinate Th(IV) complex is proposed for Th(IV)–TTHA. Certain acetate protons in the Th(IV)–TTHA chelate undergo stereospecific deuteration in alkaline D_2O at 95°. (auth)

11601 SYNTHESIS OF POLYGLUTATHIONE, POLYASPARTHIONE, AND RELATED SEQUENTIAL POLYPEPTIDES. Kovacs, J.; Kalita, C.; Ghatak, U. R. (St. John's Univ., Jamaica, N. Y.). J. Org. Chem.; 37: No. 1, 30-4(14 Jan 1972).

Polypeptides with repeating sequence of glutathione, asparthione, and their α analogs were synthesized. The protected polypeptides, poly(α-benzyl-L-glutamyl-S-benzyl-L-cysteinylglycine) (XIV), poly(α-benzyl-L-aspartyl-S-benzyl-L-cysteinylglycine) (XV), poly(γ-benzyl-L-glutamyl-S-benzyl-L-cysteinylglycine) (XVI), and poly(β-benzyl-L-aspartyl-S-benzyl-L-cysteinylglycine) (XVII), were prepared by self condensation of the corresponding tripeptide pentachlorophenyl esters IV, V, IX, or X and XII or XIII, respectively. The optically pure tripeptide active esters were obtained through the "backing off" method from the C-terminal glycine pentachlorophenyl ester. The C- and S-benzyl protecting groups from the polymers XIV, XV, XVI, and XVII were removed with sodium–liquid ammonia to afford polyglutathione (XVIII), polyasparthione (XIX), polyisoglutathione (XX), and polyisoasparthione (XXI), with weight average molecular weights of 9000, 7000, 16,000, and 6000, respectively. Polyglutathione was investigated for radioprotective activity. Polyglutathione shows a growth stimulating effect on B. subtilis. (auth)

11602 ELECTROCHEMICAL PROPERTIES OF URANIUM IN MOLTEN ACETAMIDE. Petit, Nicole (CEA, Fontenay-aux-Roses, France). J. Electroanal. Chem. Interfacial Electrochem.; 31: No. 2, 375-92(1971). (In French).

The electrochemical properties of uranium as a function of the acidity of the medium were studied in molten acetamide at 98°C, the ionic strength being kept at 1 mole kg^{-1} by the addition of tetramethylammonium chloride. At a mercury electrode in a medium of low acidity ($[H^+] < 2 \times 10^{-2}$ mole kg^{-1}) uranium(VI) is reduced to uranium(V), which undergoes disproportionation; in more acid medium ($[H^+] > 10^{-1}$ mole kg^{-1}) uranium(VI) goes to the (IV) oxidation state. At the same electrode, uranium(IV) can be reduced to uranium(III), but not oxidized. The oxidation of uranium(IV) can be achieved at a bright platinum electrode in the presence of water. (auth)

11603 KINETICS OF THE REACTION OF AMERICIUM(III) WITH PEROXYDISULFATE. Ohyoshi, Akira; Jyo, Akinori; Shinohara, Tetsuo (Kumamoto Univ., Japan). Bull. Chem. Soc. Jap.; 44: No. 11, 3047-51(Nov 1971).

Kinetic studies of the americium(III) oxidation have been made in aqueous solutions. The reaction rates were dependent on the concentrations of hydrogen, peroxydisulfate, and the silver ion as catalyzers, and on the reaction temperature. The period of induction observed in the initial stage of reaction varied with the concentration of the reactant and with the reaction temperature. The data follow this rate expression: $-d[Am(III)]/dt = K_h(k_1 + k_2[Ag^+])[S_2O_8^{2-}][Am(III)] \cdot 1/[H^+]$ where K_h is the dissociation constant of hydrogen peroxydisulfate, and where k_1 and k_2 refer to the silver-ion uncatalyzed and catalyzed paths, respectively. The energies of activation were determined to be 28.6 kcal/mole for k_1 and 17.4 kcal/mole for k_2. (auth)

11604 PHOTOCHEMICAL REACTIONS OF URANYL IONS WITH ORGANIC COMPOUNDS. IV. THE URANYL FLUORESCEN QUENCHING BY ALIPHATIC ALCOHOLS. Sakuraba, Shukichi; Matsushima, Ryoka (Shizuoka Univ., Hamamatsu, Japan). Bull. Chem. Soc. Jap.; 44: No. 11, 2915-18(Nov 1971).

The relative rates for uranyl fluorescence quenching by aliphatic alcohols (methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, and s-butyl alcohols) were measured under various conditions. The rates were increased in proportion to the perchloric acid concentration at pH < 1, whereas the rates were smaller and nearly constant at the pH's between 1 to 4; thus showing the involvement of both acid-dependent and acid-independent processes. Though the rates for both processes changed with the change in the alcohol structure (the polar substituent effect), the ratio of the two rate constants was nearly constant. The inhibitory effects of cupric ions (as a scavenger for the one-equivalent redox intermediates) suggested that the acid-dependent quenching process involves a two-equivalent redox or two consecutive one-equivalent redox steps between the same partners. The mechanisms of these quenching processes are discussed. (auth)

11605 EXTRACTION OF TERNARY COMPLEXES OF RARE EARTH ELEMENTS WITH 2-THENOYLTRIFLUOROACETONE AND 1,10-PHENANTHROLINE. Kononenko, L. I.; Tishchenko, M. A.; Vitkun, R. A.; Drobyazko, V. N. (Inst. of General and Inorganic Chemistry, Odessa). Ukr. Khim. Zh.; 37: No. 8, 829-34(Aug 1971). (In Russian).

The rare earth elements are capable of forming complexes of the type MeL_3B, where Me is a rare earth ion, L is a β-diketone such as 2-thenoyltrifluoroacetone (TTFA), indexed as 4,4,4-trifluoro-1-(2-thienyl)-1,3-butanedione, and B is an organic base such as 1,10-phenanthroline (PA). A number of variables were investigated for their effect on the complex-forming reaction: pH, ratio of Nd/TTFA concentrations, and ratio of Nd/PA concentrations. (K.S.W.)

11606 SYNTHESIS AND IDENTIFICATION OF HEPTAVALENT Pu COMPOUNDS. Pages, Monique; Nectoux, Francoise; Freundlich, William (Institut du Radium, Paris). Compt. Rend., Ser. C; 273: No. 16, 978-80(18 Oct 1971). (In French).

Heptavalent Pu compounds $M_3^I Pu^{VII}O_5$ were prepared by the direct reaction of Pu dioxide with the alkali superoxides, RbO_2 and CsO_2, at 250°C. These phases are isotypic with each other and with those of Np. Their thermal decomposition leads to a

quadratic Pu(VI) phase: $M_2Pu(VI)O_4$, an isotype of $M_2Np(VI)O_4$. (France)

Isotope Effects and Exchange

Refer also to abstracts 11762, 11806, 11851, 11873, 11907, and 13023.

11607 INFRARED SPECTRA OF MATRIX ISOLATED ACETIC ACID DIMERS. Grenie, Yves; Cornut, Jean-Claude; Lassegues, Jean-Claude (CNRS, Talence, France). J. Chem. Phys.; 55: No. 12, 5844-6(15 Dec 1971).

The expected isotopic shifts between $(CH_3COOH)_2$ and $(CH_3C^{18}O^{18}OH)_2$ were evaluated by using the observed isotopic shifts of the ir internal vibrations and assuming that they are identical for the corresponding Raman lines. Studies were also made on $(CD_3COOH)_2$. (M.C.G.)

11608 MATRIX-ISOLATED SILANE. INFRARED SPECTRA. Wilde, R. E.; Srinivasan, T. K. K.; Harral, Richard W.; Sankar, S. G. (Texas Tech. Univ., Lubbock). J. Chem. Phys.; 55: No. 12, 5681-92(15 Dec 1971).

The infrared spectra of silane and its deuterated species isolated in solid neon, argon, krypton, xenon, nitrogen, carbon monoxide, and methane were obtained. In addition, argon–krypton mixed-matrix studies and oxygen-doping experiments were done. It is shown that silane occupies at least two types of defect sites. There is no evidence for free or nearly free rotation of silane in any of the matrices. (auth)

11609 VAPOR PRESSURE ISOTOPE EFFECT NEAR THE TRIPLE POINT. Jeevanandam, M. (Yeshiva Univ., New York). J. Chem. Phys.; 55: No. 12, 5735-41(15 Dec 1971).

The large discontinuity of the vapor pressure isotope effect (VPIE) observed near the triple point is discussed with the application of Bigeleisen's theory of equilibrium isotope effects in condensed phases to Eyring's significant structure theory of liquids. The partition function ratios were calculated for monatomic, diatomic, and polyatomic systems, and they are in good agreement with the experimental values. The simple molar volume change (V_s/V_l) is found to be adequate to explain the change in the vapor pressure ratios of $^{36}Ar/^{40}Ar$, $^{20}Ne/^{22}Ne$, $^{12}C^{16}O/^{13}C^{16}O$, $^{12}C^{16}O/^{12}C^{18}O$, and $^{12}CH_4/^{13}CH_4$ systems, especially near the melting region. When the structural change at the melting point of ice is also taken into account, the VPIE is satisfactorily explained in the H_2O/D_2O system. The "crossover" phenomenon observed in systems like the isotopic methanes can be explained when the difference in the rotational contribution to the ratio of the reduced partition function ratios between the liquid and solid states is also taken into account. For isotopic hydrogen with large quantum effects, the isotope effect on the molar volume ratio must be included. (auth)

11610 PRESSURE JUMP RELAXATION KINETICS OF THE COMPLEXATION OF NICKEL MALONATE IN D_2O. Saar, David; Macri, Gerard; Petrucci, Sergio (Polytechnic Inst. of Brooklyn). J. Inorg. Nucl. Chem.; 33: No. 12, 4227-37(Dec 1971).

Pressure jump relaxation kinetic results of the complexation of Ni^{2+} by malonate ion in deuterium oxide at various temperatures are reported. The data are interpreted by the three step mechanism of Eigen starting from the diffusion controlled approach between the solvated ions and ending with the closing of the chelate ring. The rate determining step is the removal of the first solvent molecule around Ni^{2+}. Comparison of the activation parameters $\Delta H^{\ddagger}_{23}$ and $\Delta S^{\ddagger}_{23}$ suggests that for both solvents the complexation process has a dissociative mode of activation. (auth)

11611 ELECTRICAL MOBILITIES OF ^6Li AND ^7Li IONS IN MOLTEN NITRATES: RELATION BETWEEN THE ISOTOPE EFFECT AND THE IONIC INTERACTIONS. Lantelme, F.; Turq, P. (Univ., Paris). J. Inorg. Nucl. Chem.; 33: No. 12, 4025-33(Dec 1971).

The electrical mobilities of ^6Li and ^7Li ions in molten nitrates were studied by electrophoresis. The isotope effects at temperatures from 250°C to 400°C were measured in the low melting point mixture $NaNO_3$–KNO_3, and a large increase in the isotope effect was observed with increasing temperature. These results are correlated with the transport properties of lithium and of the constitutive elements of the melt. It is shown that ionic interactions strongly influence the isotope effect; by describing these interactions as inducers of a multi-order process it is possible to show that the isotope effect is mainly due to the isotope distribution between these different modes of migration. (auth)

11612 OSMOTIC AND ACTIVITY COEFFICIENTS OF SOME SOLUTES IN DEUTERIUM OXIDE. Bonner, O. D. (Univ. of South Carolina, Columbia). J. Chem. Thermodyn.; 3: No. 6, 837-41(Nov 1971).

Osmotic and activity coefficients are reported for 11 solutes in D_2O at 25°C. Activity coefficients of lithium and sodium salts are somewhat larger in D_2O than in H_2O while those of caesium and silver salts are smaller. The activity coefficients of dextrose and sym-dimethylurea are surprisingly large in D_2O. A comparison is made of the excess Gibbs free energies of the solutes in H_2O and D_2O, and the relation between excess thermodynamic quantities and the corresponding thermodynamic quantities for the transfer of a solute from one solvent to the other is noted. (auth)

11613 NUCLEOPHILIC ADDITION REACTIONS OF KETONES. ADDITION OF THE SULPHITE ION: DETECTION OF HYPERCONJUGATION BY MEASURING THE SECONDARY ISOTOPE EFFECT OF DEUTERIUM. Geneste, P.; Lamaty, G.; Roque, J. P. (Univ., Montpellier, France). Tetrahedron; 27: No. 22, 5539-59(Nov 1971). (In French).

The rates of addition, at 25°C in water, of the SO_3^{--} ion to nine saturated ketones and their α-deuterated homologs were measured. The secondary kinetic isotope effects, expressed by the ratios $(k^H/k^D)_f$, were determined. The isotope effect during the hydrolysis of bisulfite addition compounds of twelve ketones: $(k^H/k^D)_d$ was measured. These isotope effects are discussed in terms of electronic and steric factors. The transition state was shown to be "reactant-like" for the addition reaction: the inductive and steric factors are of little importance, if any. The main factor, responsible for the isotope effects, seems to have a hyperconjugative origin: the deuterated ketone is less stabilized by $\sigma-\pi^*$ overlap than the normal one. The variations of the isotope effect from one compound to another are easily interpreted by the consideration of the stable conformations of the ketone and the change of hyperconjugative stabilization from one ketone to another. (auth)

11614 NUCLEOPHILIC ADDITION REACTIONS OF KETONES. ADDITION OF HYDROXYLAMINE: DETECTION OF STERIC FACTORS BY MEASURING THE SECONDARY ISOTOPE EFFECT OF DEUTERIUM. Geneste, P.; Lamaty, G.; Roque, J. P. (Univ., Montpellier, France). Tetrahedron; 27: No. 22, 5561-78(Nov 1971). (In French).

The rates of addition of NH_2OH, in water at 25°C, to seventeen ketones and their α-deuterated homologs were measured. The secondary kinetic isotope effects are expressed by the ratio k^H/k^D. The reaction rates were measured in an acidic medium, and in these conditions the rate determining step is the attack of the free nucleophile on the carbonyl group of the ketone. The isotope effects are discussed in terms of electronic and steric factors. For this reaction the transition state is "reactant-like." As already observed in the addition of SO_3^- ion, the hyperconjugative factor is still operating in this case; however due to the shortness of the incipient C–N bond, two kinds of steric effects are superimposed on the hyperconjugation. These steric effects, called "effet stérique d'approche" and "effet stérique de torsion," stem from the interaction between the α C–H bonds and the incipient nucleophile and are, generally, mutally exclusive. The "effet stérique de torsion" can arise when the NH_2OH molecule approaches the substrates along a line perpendicular to the plane of the C=O group. In the other cases the "effet stérique d'approche" is operative. (auth)

11615 ELIMINATION REACTIONS PROMOTED BY FLUORIDE ION IN ACETONITRILE. ELIMINATION REACTION FROM 2-ARYLETHYL DERIVATIVES. Hayami, Jun-ichi; Ono, Noboru; Kaji, Aritsune (Kyoto Univ.). Bull. Chem. Soc. Jap.; 44: No. 6, 1628-32(Jun 1971).

Rates of bimolecular elimination were determined for the reaction of 2-arylethyl bromides, chlorides, and tosylates with anhydrous tetraethylammonium fluoride in acetonitrile. The rates of elimination reactions in this new base system were much faster than those in conventional base systems (alkoxide–alcohol). The Hammett ρ values were found to be $\rho = 2.033$ (X = Cl) at 25.0°C and $\rho = 1.879$ (X = Br) at 5.0°C for p-Y-$C_6H_4CH_2$-CH_2X. Kinetic deuterium isotope effects were determined using 2-phenylethyl-2,2-d_2 bromide and chloride to be $k_H/k_D = 3.99$ (X = Cl) and 5.03 (X = Br). These data and the low k_{OTs}/k_{Br} ratio suggest that fluoride-ion-promoted elimination reaction proceeds through a very tight transition state where β-proton is less than half transferred to the base. (auth)

11616 DIMERIZATION OF C_2D_4 CATALYZED BY BIS(TRIPHENYLPHOSPHINE)-σ-1-NAPHTHYL NICKEL (II) BROMIDE.

Maruyama, Ken-ichi; Kuroki, Tetsufumi; Mizoroki, Tsutomu; Ozaki, Atsumu (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 44: No. 7, 2002(Jul 1971).

The mechanism of the catalysis of the selective dimerization of ethylene in the presence of boron trifluoride etherate in dry methylene chloride by bis(triphenylphosphine)-σ-1-naphthyl nickel(II) bromide was investigated. The isotopic exchange between C_2H_4 and C_2D_4 and between C_2D_4 and other chemical species involved in the reaction system of the dimerization was studied. It was found that the rate of isotopic exchange is strikingly faster than the ethylene dimerization, and that one hydrogen atom is exchanged in one act of the exchange. It is concluded that the isotopic exchange and the dimerization of ethylene is catalyzed by a nickel hydride complex that is formed by the reaction of ethylene with the nickel complex. (J.G.B.)

11617 SOLVOLYSIS OF ORGANIC PHOSPHATES. III. 3-PYRIDYL AND 8-QUINOLYL PHOSPHATES IN SPONTANEOUS REACTION. Murakami, Yukito; Sunamoto, Junzo (Kyushu Univ., Fukuoka). Bull. Chem. Soc. Jap.; 44: No. 7, 1939-44(Jul 1971).

The spontaneous hydrolysis of 3-pyridyl and 8-quinolyl phosphates was investigated at 60, 70, and 80°C over the $-\log[H^+]$ range from 1 to 7 in aqueous media with an ionic strength of 0.10. The reactions followed apparent first-order kinetics with respect to the unreacted phosphate species, and the maximum rate was observed around $-\log[H^+] = 2.5$. Reactive species of each phosphate in hydrolysis were the neutral zwitterion and the monoanion, the former being found to be more labile. In a moderately acidic region ($-\log[H^+] < 2.0$), an apparent enhancement of the reaction rate was detected for both phosphates, which was attributed to the acid catalysis acting on the zwitterion species. The activation enthalpy for hydrolysis of the zwitterion and the monoanion falls near 30 kcal mole^{-1}. This is consistent with the reaction mechanism expected for hydrolysis of ordinary monoalkyl or monoaryl phosphate, in which the P—O bond cleavage takes place. The activation entropy data also provide an evidence for the unimolecular nature of the transition state. The kinetic solvent isotope effect k_{H_2O}/k_{D_2O} for the hydrolysis of both phosphates falls near unity. The isotope effect in this magnitude is consistent with the intramolecular proton-transfer mechanism. The results are, therefore, consistent with a mechanism for the hydrolysis of the zwitterion species of 8-quinolyl phosphate in which the quinolinium group donates a proton intramolecularly to the leaving ester oxygen atom in the transition state. (auth)

11618 ANOMALY IN THE CATION ISOTOPE EXCHANGE KINETICS IN VERMICULITE TRANSVAAL. Levi, H. W.; Miekeley, N. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Radiochim. Acta; 16: No. 3-4, 182-5(Dec 1971). (In German).

Ca, Sr, and Ba isotopic exchange was measured in vermiculite-Transvaal. Plots of Dt/r_0^2 vs. t showed a convex curvature at the beginning of the run passing over to a straight line later. This anomalous behavior was found to be due to the presence of alternating vermiculite and biotite layers. When the material is being loaded with the ions to be studied the vermiculite layers are fully transformed into the new form whereas the biotite layers are attacked only at their edges. The kinetic anomaly could be overcome by using larger pieces of the material so that the fraction of each biotite layer being loaded remains very small. (auth)

11619 KINETIC STUDY OF THE SOLVENT ISOTOPE EFFECT IN ACETIC ACID AND IN DEUTERATED ACETIC ACID. Huang, Theresa Shu-chueng Chen. Philadelphia; Univ. of Pennsylvania (1971). 140p. University Microfilms Order No. 71-26,033.

Thesis.

Study of the solvent isotope effect was undertaken in an effort to further understanding of the nature of the solvent in the acetolysis of different p-toluenesulfonic esters. The kinetics of the acetolysis of benzyl, p-methoxyneophyl, 1-adamantyl, and methyl p-toluenesulfonate were studied in acetic acid and acetic acid-d, the first three compounds at different temperatures. The rate of acetolysis of each compound was studied conductometrically by following the increase of conductivity of product with respect to time, and was shown to be pseudo-first order in nature. The average kinetic solvent isotope effects for benzyl tosylate are: 1.041 ± 0.052, 1.067 ± 0.019, and 1.100 ± 0.008 at 94.9, 80.03, and 70.20°C, respectively; for p-methoxyneophyl tosylate are: 1.095 ± 0.05, 1.116 ± 0.03, and 1.101 ± 0.027 at 80.03, 70.20, and 60.01°C, respectively; for 1-adamantyl tosylate are: 1.044 ± 0.014, 1.048 ± 0.019, and 1.060 ± 0.029 at 39.9, 30.01, and 14.9°C, respectively; for methyl tosylate is 1.028 ± 0.05 at 94.9°C. There was no appreciable difference in isotope effect with changing of alkyl group, although the nucleophilic assistance by solvent is expected to be more important for methyl than for benzyl tosylate, and nucleophilic assistance is precluded for both p-methoxyneophyl and 1-adamantyl tosylate. It is possible that the observed nearly constant solvent isotope effects might result from varying relative contribution of nucleophilic and electrophilic interactions, depending on the structure of the substrate. The logarithms of the isotope effects are almost independent of temperature for each compound studied within the experimental error. Normal isotope effects were observed for each compound studied. (Diss. Abstr. Int., B)

11620 ISOMERIZATION OF POLYENE-IRON TRICARBONYLS AND HYDROGEN/DEUTERIUM EXCHANGE IN DIENE-IRON TRICARBONYLS. Markezich, Ronald Lee. Madison, Wis.; Univ. of Wisconsin (1971). 249p. University Microfilms Order No. 71-20,678.

Thesis.

A series of irontricarbonyl shift isomers of terminally substituted polyenes was prepared and the spectral properties of these complexes is discussed. Hydrogen/deuterium exchange was observed in formyl- and cyano-substituted diene-iron tricarbonyl complexes when treated with deuterated alcohols at 25°C in the presence of base. It was shown that the exchange is stereospecific about the exchanging carbon and that the rate of exchange parallels the electronegativity of the terminal substituent. The mechanism of this exchange is discussed. (Diss. Abstr. Int., B)

11621 VIBRATIONAL SPECTRA OF AMMONIUM AND OTHER SCHEELITE-TYPE PERRHENATES. Johnson, Richard A.; Rogers, Max T.; Leroi, George E. (Michigan State Univ., East Lansing). J. Chem. Phys.; 56: No. 2, 789-92(15 Jan 1972).

The far-infrared and laser-excited Raman spectra of several scheelite-type perrhenates were recorded at 77°K and room temperature in order to obtain frequencies and symmetry assignments for the lattice modes. Both NH_4ReO_4 and ND_4ReO_4 were studied to separate ammonium ion translations and librations. At 77°K the ammonium ion librational mode is observed at 264 cm^{-1} in NH_4ReO_4 and 194 cm^{-1} in ND_4ReO_4. Upon warming to 300°K, the ammonium ion librational mode disappears and is unobservable in both the far-ir and Raman spectra. The Raman-active ammonium ion fundamental modes have also been observed in both NH_4ReO_4 and ND_4ReO_4. The temperature-dependent changes in the intensities and linewidths of the ammonium-ion fundamentals and lattice modes indicate that the ammonium ion motion undergoes a change between 77 and 300°K. (auth)

11622 INFRARED ABSORPTION SPECTRA OF ISOTOPIC OZONE ISOLATED IN RARE-GAS MATRICES. Brewer, Leo.; Wang, J. Ling-fai (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 2, 759-62(15 Jan 1972).

Some of the isotopic ozone molecules of different combinations of ^{16}O and ^{18}O were synthesized and isolated in rare-gas matrices at 20°K. Their infrared absorption bands have been identified. The isotope effects are calculated for symmetrical as well as unsymmetrical isotopic ozone molecules. (auth)

11623 MAGNETIC RESONANCE STUDIES OF THE DEUTERATION EFFECT ON INTERSYSTEM CROSSING IN THE ANTHRACENE MOLECULE. Clarke, R. H. (Univ. of Chicago). Chem. Phys. Lett.; 12: No. 1, 157-60(1 Dec 1971).

The intersystem crossing decay constants from the $^3B_{2u}$ state into the ground state of anthracene-d_{10} in a phenazine crystal have been determined by magnetic resonance techniques at 1.5°K both at high magnetic field and, by a parametrization procedure, at zero magnetic field. A comparison of the anthracene-d_{10} zero-field results with those for anthracene-h_{10} show the effects of deuterium substitution to be largest for the in-plane spin levels of the anthracene triplet state. (auth)

11624 E1cB ELIMINATIONS IN DERIVATIVES OF BORNANOL. Finder, Cary Jay. Gainesville, Fla.; Univ. of Florida (1970). 88p. University Microfilms Order No. 71-24,421.

Thesis.

The piperidine-induced eliminations of some conformationally biased β-sulfonyl alcohol derivatives were studied kinetically. The compounds used were trans-2-(p-tolylsulfonyl)-4-t-butylcyclohexyl hydrogen phthalate (I), the acetate ester (IIa), and the N-phenyl carbamate (IIb) of d-3-endo-(p-tolylsulfonyl)-2-endobornanol. These systems were chosen for their poor leaving groups, relatively acidic hydrogen α to the sulfone, and conformational bias such that the acidic hydrogen and leaving group could attain neither a syn nor anti relation to each other. The piperidine-induced elimination from I was followed conductometrically using a 40% piperidine in dimethylformamide mixture as solvent, and piperidinium and lithium p-toluenesulfonate as added salts. The eliminations from IIa and IIb were followed polarimetrically

using an 18% piperidine in sulfolane mixture as solvent and lithium perchlorate as one of the added salts. Neither rate retardation with added base salt nor hydrogen–deuterium exchange was observed. The k_H/k_D for I was 1.51 and k_H/k_D for IIb was 1.60. These were compared with the maximum k_H/k_D predicted for an E1cB by two different theoretical approaches. One approach indicated that a small amount of bonding might remain in the intermediate. This could be attributed to a hydrogen bond. The data fit an intermediate intimate ion pair, which permitted neither rate retardation nor hydrogen–deuterium exchange. This conclusion is supported by a rate acceleration, found upon addition of lithium ion, which is similar in size and effect to the special salt effect found by Winstein and Robinson in a solvolysis reaction, and similar in effect to that found by Hogen–Esch and Smid. This type of salt effect might be useful in reactions which have been termed $(E1cB)_{ip}$. (Diss. Abstr. Int., B)

11625 ISOTOPIC OXYGEN EXCHANGE STUDIES ON SOME Re(V) COMPLEXES. Toppen, David Livingstone. Columbia, Mo.; Univ. of Missouri (1971). 176p. University Microfilms Order No. 71-22,947.

Thesis.

The isotopic oxygen exchange between the trans-dioxotetracyanorhenate(V) anion and water was studied in both acidic and basic media. The reaction is: $[ReO_2(CN)_4]^{3-} + H_2O \rightarrow [ReO_2(CN)_4]^{3-} + H_2\overset{*}{O}$. The dependence of the rate of oxo-ligand exchange on hydrogen ion, hydroxide ion, cyanide ion, and complex ion concentrations and on temperature was investigated. The overall rate expression which most clearly described the data was $R = k_1[ReO(OH)(CN)_4^{2-}] + k_4[ReO_2(CN)_4^{3-}][OH^-]^{0.22}[CN^-]^{0.30}$. Using this expression, the values of k_1 and k_4 at 35.0°C were found to be $3.42 \pm 0.05 \times 10^{-2}$ sec^{-1} and $2.15 \pm 0.30 \times 10^{-12}$ Msec^{-1}, respectively. The activation energies, E_{act}, for the k_1 and k_4 paths were 23.3 ± 0.3 and 20.3×0.1 kcal/mole, respectively. In acidic media a mechanism was proposed in which removal of an oxo-ligand from the complex is facilitated by protonation. The mechanism proposed for exchange in basic media involved solvent replacement of an equatorial cyanoligand with consequent axial oxo-ligand labilization. During studies on the behavior of $[ReO_2(CN)_4]^{3-}$ in acidic solution, the dimeric μ-oxo-bis{oxotetracyanorhenate(V)} anion was isolated and characterized. The isotopic oxygen exchange between the bridging and terminal oxo-ligands and solvent was investigated. The rate of terminal oxo-ligand exchange was best described by the rate expression: $R = k_1[Re_2O_3(CN)_8^{4-}] + k_2[Re_2O_3(CN)_8^{4-}][H^+]$. At 50°C the values of k_1 and k_2 were $1.11 \pm 0.07 \times 10^{-4}$ sec^{-1} and $3.46 \pm 0.24 \times 10^{-2}$ M^{-1} sec^{-1}, respectively. The activation energy for terminal oxo-ligand exchange was 30.3 ± 0.9 kcal/mole. At 70.3°C, $[H^+] = 2.0 \times 10^{-4}$, the rate of exchange of the terminal oxo-ligands was observed to be forty times faster than the rate of exchange of the bridging oxo-ligand. A mechanism was proposed in which removal of a terminal oxo-ligand is facilitated by association with hydrogen ion. Exchange of the bridging oxo-ligand was proposed to be carried by exchange of acid dependent equilibrium concentrations of $[ReO_2(CN)_4]^{3-}$. (Diss. Abstr. Int., B)

11626 STRUCTURE OF THE $^2A_1''$ STATE OF NH_3^+. Harshbarger, William R. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 56: No. 1, 177-82(1 Jan 1972).

Franck–Condon factors for the transition from the ground state of ammonia to the $^2A_1'$ ionic state were calculated. Calculations were made using three different descriptions of the excitation of the ion from the ground state. The results of these calculations were compared with the relative intensities for the transition observed in the photoelectron spectra of NH_3 and ND_3. This comparison indicates that in the $^2A_1''$ state, the ion has a planar configuration. The symmetric stretching mode of vibration of the ion, with a frequency of 2850 ± 100 cm^{-1} for NH_3^+ and 2150 ± 100 cm^{-1} for ND_3^+, is excited in the transition, as well as the inversion mode of vibration. The N–H bond length for the $^2A_1'$ state of the ion is determined to be 1.07 ± 0.01 Å. (auth)

11627 MECHANISM OF ACTION OF COENZYME B_{12}. HYDROGEN TRANSFER IN THE ISOMERIZATION OF β-METHYLASPARTATE TO GLUTAMATE. Eagar, R. G. Jr.; Baltimore, B. G.; Herbst, M. M.; Barker, H. A.; Richards, J. H. (California Inst. of Tech., Pasadena. Univ. of California, Berkeley). Biochemistry; 11: No. 2, 253-64(18 Jan 1972).

Use of a mixture of unlabeled and tetradeuterio-β-methylaspartate with coenzyme B_{12} dependent β-methylaspartate–glutamate mutase has shown that the hydrogen that migrates becomes one of three equivalent hydrogens during the isomerization. Kinetic isotope effects suggest that cleavage of the bond in the substrate from carbon to that hydrogen which migrates is an important component of the rate-determining step. The evidence also supports the existence of an intermediate which can partition with similar probabilities to β-methylaspartate or to glutamate. Mechanistic implications of these findings are discussed. (auth)

11628 MILLIMETER-WAVE SPECTRUM AND STRUCTURE OF HYPOFLUOROUS ACID: HOF AND DOF. Kim, Hyunyong (Univ. of Missouri, Columbia); Pearson, Edwin F.; Appelman, Evan H. J. Chem. Phys.; 56: No. 1, 1-3(1 Jan 1972).

The microwave spectra of two isotopic species of hypofluorous acid, HOF and DOF, were investigated. The values of the A_0, B_0, and C_0 rotational constants are 590,000, 26,758.00, and 25,512.51 MHz for HOF and 316,800, 25,591.25, and 23,587.75 MHz for DOF. The structural parameters calculated with these rotational constants are: $r(O-H) = 0.964 \pm 0.01$ Å, $r(O-F) = 1.442 \pm 0.001$ Å, and $\angle HOF = 97.2° \pm 0.6°$. Centrifugal distortion analysis in the symmetric top approximation gave D_J and D_{JK} values of 0.0934 and 2.417 MHz for HOF and 0.0775 and 1.745 MHz for DOF, respectively. The P^6 distortion term was not significant. (auth)

11629 MECHANISM OF DECARBOXYLATION OF MONOETHYL OXALACETATE. Tsai, C. S.; Lin, Y. T.; Sharkawi, E. E. (Carleton Univ., Ottawa). J. Org. Chem.; 37: No. 1, 85-7(14 Jan 1972).

The monoethyl ester of oxalacetic acid was synthesized and its rate of decarboxylation studied. While the rate of decarboxylation of nonionized monoethyl oxalacetate is not affected by a change in the solvent polarity, the rate of decarboxylation of its anion is facilitated by a lowering of the polarity of solvents. In contrast to the decarboxylation of the nonionized monoester which exhibits the kinetic deuterium isotope effect, the decarboxylation of its anion is insensitive to the deuterium isotope. Reaction mechanisms consistent with experimental results are proposed for the decarboxylation of the nonionized and anionic oxalacetates. (auth)

11630 LOW-FREQUENCY MODES IN MOLECULAR CRYSTALS. XVII. TORSIONAL MOTIONS AND BARRIERS TO INTERNAL ROTATION IN SOME ETHYLSILANES, ETHYLGERMANES, AND ETHANOL. Durig, J. R.; Hawley, C. W. (Univ. of South Carolina, Columbia). J. Phys. Chem.; 75: No. 26, 3993-4000(23 Dec 1971).

The far-infrared spectra of solid $CH_3CH_2SiH_3$, $CH_3CH_2SiD_3$, $CH_3CH_2SiCl_3$, $CH_3CH_2GeH_3$, $CH_3CH_2GeCl_3$, CH_3CH_2OH, and CH_3CD_2OD have been recorded. The low-frequency Raman spectra were also recorded for all the solids except ethanol. The interesting CH_3 torsional modes were observed in the spectra of the solids at 211, 210, 257, 189, 245, 282, and 251, and 198 and 184 cm^{-1}, with corresponding barriers of 2.82, 2.88, 4.41, 2.33, 4.03, 4.05, and 4.04 kcal/mol for ethylsilane, ethylsilane-d_3, ethyltrichlorosilane, ethylgermane, ethyltrichlorogermane, ethanol, and ethanol-d_4, respectively. The SiH_3 and GeH_3 torsional modes were observed at 142 and 113 cm^{-1}, which leads to respective barrier heights of 1.99 and 1.37 kcal/mol. Assignments are proposed for the other low-frequency modes. The trends in the barriers are discussed in terms of present theory. (auth)

11631 REACTION OF $O(^3P)$ WITH DIDEUTERIOACETYLENE. Williamson, David G. (California State Polytechnic Coll., San Luis Obispo). J. Phys. Chem.; 75: No. 26, 4053-6(23 Dec 1971).

The reaction of atomic oxygen, $O(^3P)$, with C_2D_2 was studied to determine the importance of D atom production in this reaction. By measuring the yield of HD from the exchange reaction of D atoms with H_2, the D atom yield was estimated to be (42 ± 10%) based on the number of $O(^3P)$ atoms generated. (auth)

11632 HYDROGEN CHLORIDE CATALYZED ^{18}O EXCHANGE BETWEEN PARA-SUBSTITUTED PHENYL METHYL SULFOXIDES AND WATER. Ookuni, Ikuo; Fry, Arthur (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-3234. J. Org. Chem.; 36: No. 26, 4097-4101(31 Dec 1971).

Para-substituted phenyl methyl ^{18}O-labeled-sulfoxides undergo oxygen-18 exchange with water in aqueous dioxane solutions of most mineral acids (reduction of the sulfoxides to sulfides takes place with hydrobromic and hydroiodic acids), but hydrochloric acid is a more effective catalyst by at least a factor of ten than other mineral acids at the same concentration. A much slower base-catalyzed exchange was also detected. For the hydrogen chloride catalyzed exchange, the relative rates for p-methoxy-, p-methyl-, unsubstituted, p-chloro-, and p-nitrophenyl methyl sulfoxides are 2.18, 1.61, 1.00, 0.52, and 0.21, respectively. A Hammett plot of $\log k/k_0$ vs σ is linear with $\rho = 1.046$. Coupled with the work of others, these results indicate that there are at least four mechanisms for oxygen-18 exchange between sulfoxides and water. (auth)

11633 DEUTEROLYSIS OF MONOFLUOROPHOSPHATE. Min, K. W.; Rands, D. G.; Bain, R. L. (Southern Illinois Univ., Edwardsville). Inorg. Chem.; 11: No. 1, 184-5(Jan 1972).

The kinetics observed for the deuterolysis of PO_3F^{2-} are reported as a function of pD and temperature. A kinetic isotope effect of 2.1 was observed. A mechanism for the deuterolysis reaction is proposed. (J.G.B.)

11634 SECONDARY DEUTERIUM ISOTOPE EFFECTS AS MECHANISTIC PROBES IN PHOTOCHEMICAL REACTIONS. Sovocool, George Wayne. Ithaca, N. Y.; Cornell Univ. (1971). 171p. University Microfilms Order No. 71-25,169.

Thesis.

Secondary deuterium isotope effects were developed as a means of mechanistically distinguishing the principal modes of interaction of triplet state electronically excited ketone molecules with olefins. The expected mechanisms were sensitizer addition to olefin (Schenk mechanism), excitation transfer, and charge transfer, or exciplex formation. Chemical systems were selected in which a Schenk mechanism could have been expected to lead to the production of stable 1,4-biradicals; a benzyl radical from addition to trans-β-methylstyrene, causing its isomerization, and addition to the methylene carbon of isotobutylene to form a tertiary radical, leading to oxetane formation. Analogy to ground state reactions would predict an inverse ($k_H/k_D < 1.0$) secondary deuterium isotope effect for sensitizer addition to olefin substrates. In the trans- to cis-isomerization of β-methylstyrene quantum yields, photostationary states and rate constants were all consistent with, although not exclusively requiring an excitation transfer mechanism. Isotope effect studies were made as a function of sensitizer energy, sensitizer type (n,π^* and π,π^*), and position of dueterium substitution in the β-methylstyrene. Sensitizers with triplet state energies above the triplet state of β-methylstyrene showed no isotope effect. Both n,π^* and π,π^* sensitizers with triplet state energies below the olefin triplet state gave isotope effects of $k_H/k_D = 1.14 \pm 0.02$ for β-deuterated olefin. The isotope effects (k_H/k_D) varied with position of deuteration in trans-β-methylstyrene as: beta (1.14), alpha (1.06), para (1.05) and meta (1.01). Correlation of the isotope effects with the change in free valence index from ground to vertical, first excited state was achieved. The following principal conclusions resulted: (1) the isotope effect on partitioning of the olefin triplet to cis and trans ground states was nil; (2) significant involvement of remote positions in the excitation-transfer process occurred; (3) sensitizers with widely differing types of chromophore showed essentially identical isotope effects, emphasizing the similarity of the bimolecular interactions; and (4) the origins of the deuterium isotope effect were probably more closely allied with the effect of deuterium on excitation energy than with the effect on Franck–Condon factors associated with twisting around the α,β bond in the olefin triplet state. Preliminary studies of the cis- to trans-isomerization were not obviously consistent with a vertical transition. Isobutylene and benzophenone form 3,3-dimethyl-2,2-diphenyl- and 2,2-dimethyl-4,4-diphenyloxetanes in 10:1 ratio, with total quantum yield of 0.09 and chemical yield of 95%. The isotope effects (k_H/k_D) measured for the major and minor oxetanes were 0.935 ± 0.015 and 0.9 ± 0.1, respectively per deuterium. This was in contrast to an isotope effect $k_H/k_D = 1.03$ previously measured for the formation of oxetanes from 2-butene. The rate constant for isobutylene quenching of benzophenone triplet state was measured as $1.5 \pm 0.5 \times 10^7$ M^{-1} sec^{-1}, faster than model radical addition reactions, yet consistent with the difference in ionization potential causing a lower rate than that measured for 2-butene (8×10^7 M^{-1} sec^{-1}). The results were interpreted on the basis of the formation of a charge-transfer intermediate. (Diss. Abstr. Int., B)

11635 SOLVENT ISOTOPE EFFECTS. PART I. AQUEOUS SOLUTION STRUCTURE AS DETERMINED FROM THERMODYNAMIC PARAMETERS OF TRANSFER FROM H_2O TO D_2O. PART II. SOLVENT EFFECTS ON THE KINETICS AND EQUILIBRIA ASSOCIATED WITH THE INTERCONVERSION OF 3-METHYLACETYLACETONE IN H_2O–D_2O MIXTURES. Dahlberg, Donald Bernard. Ithaca, N. Y.; Cornell Univ. (1971). 63p. University Microfilms Order No. 71-25,154.

Thesis.

The free energy and enthalpy of transfer from H_2O to D_2O at 25°C were measured for several ketones and alcohols. These data, combined with results from other laboratories, were interpreted in terms of solvent structure breaking and making spheres of influence caused by polar and nonpolar groups of the solute and interactions caused by the overlap of such spheres. The keto–enol and acid dissociation equilibrium constants for 3-methylacetylacetone were measured in pure H_2O and D_2O at 25.0°C. The rates of ionization of the keto form were determined by bromination in H_2O–D_2O mixtures for water and acetate catalysts. Fractionation factors and degenerate activity coefficients at 25.0°C were determined for stable species. These data were analyzed in terms of Gross–Butler equations containing medium effect terms, thus allowing the determination of degenerate activity coefficients and fractionation factors for transition states involved in the ionization of the ketone. The resultant fractionation factors are discussed in terms of vibrational frequencies, and degenerate activity coefficients are discussed in terms of solution structure. (Diss. Abstr. Int., B)

11636 ESTABLISHMENT OF EQUILIBRIA IN THE ISOTOPIC DISTRIBUTION OF HYDROGEN AND DEUTERIUM BETWEEN PALLADIUM AND AQUEOUS SOLUTIONS. Bucur, R. (Inst. for Atomic Physics, Cluj); Lewis, F. A. Z. Phys. Chem. (Frankfurt); 75: No. 3-4, 207-11(Aug 1971).

Preliminary results are reported on an experimental variant of exchange studies with palladium electrodes in which the involvement of gaseous hydrogen is minimized, and in which the possibilities of obtaining incorrect estimates of the isotopic compositions of hydrogen absorbed in electrodes are reduced. Pairs of electrodes are used. One electrode is charged with pure hydrogen, the other with pure deuterium, and then they are introduced together into solutions having various ratios of H_2O/D_2O. After 18 hours or less, the electrodes were removed from solution, fully outgassed in vacuum, and the composition of the released gas analyzed by a mass spectrometer. The D_2O content of the solution was determined at the same time. When high ratios of deuterium are involved, results are compatible with values of 6 for the isotopic separation factor $S_{M,L}$, defined as $S_{M,L}$ = [(H/D) gas in metal]/[(H/D) liquid phase]. (M.C.G.)

11637 CONFORMATIONS OF THE ESTERS. II. THE CONFORMATION OF ALKYL ACETATES. Oki, Michinori; Nakanishi, Hiroshi (Tokyo Univ.). Bull. Chem. Soc. Jap.; 44: No. 11, 3144-7(Nov 1971).

Alkyl acetates which carry secondary and tertiary alkyl groups have been found to have bifurcated bands in the carbonyl region of the infrared spectra. The origin of the bifurcated bands has been studied carefully, and it has been concluded that the Fermi resonance is the most probable origin of the phenomenon. The ir spectra of deuterated and normal tert-butyl acetate are given. (auth)

11638 S_N2 REACTIONS IN DIPOLAR APROTIC SOLVENTS. CHLORINE ISOTOPIC EXCHANGE REACTIONS OF 2-ARYLETHYL CHLORIDES, CHLOROMETHYL ARYL ETHERS, AND CHLOROMETHYL ARYL SULFIDES IN ACETONITRILE. Hayami, Jun-ichi; Tanaka, Nobuo; Kurabayashi, Syuji; Kotani, Yasuhiro; Kaji, Aritsune (Kyoto Univ.). Bull. Chem. Soc. Jap.; 44: No. 11, 3091-5(Nov 1971).

The S_N2 reactions having a symmetrical transition state were studied in a dipolar aprotic solvent. A good Hammett correlation was found for the chlorine isotopic exchange reactions in acetonitrile between tetraethylammonium chloride and three types of substituted methyl chlorides, 2-arylethyl chlorides, chloromethyl aryl ethers, and chloromethyl aryl sulfides. The reaction constant was positive for 2-arylethyl chlorides and negative for the methyl chlorides possessing an α-heteroatom. The presence of oxygen and sulfur atom on the α-position to the reaction center resulted in a rate enhancement of about 10^5 times and 10^3 times, respectively. Features of the transition states of these S_N2 reactions are discussed. (auth)

11639 LIGHT SCATTERING BY PROPANOL SOLUTIONS IN H_2O AND D_2O. Vuks, M. F.; Shurupova, L. V. (Leningrad State Univ.). Zh. Strukt. Khim.; 12: No. 4, 712-13(Jul-Aug 1971). (In Russian).

The scattering of light by aqueous solutions of 1-propanol and 2-propanol at 22°C was investigated at a wavelength of 5,461 Å. In the case of 2-propanol, a narrow maximum in light scattering occurs at 0.06 mole fraction, which is not predicted by theory. A similar narrow maximum was observed in aqueous solutions of 1-propanol, both in H_2O and D_2O, and, in addition, a broader maximum at the alcohol mole fraction = 0.15. The cause of this scattering phenomenon is discussed. (K.S.W.)

11640 EVIDENCE OF A PRERESONANCE RAMAN EFFECT OF THE BASE RESIDUE IN A NUCLEIC ACID. Tsuboi, Masamichi (Tokyo Univ.); Takahashi, Seizo; Muraishi, Shuichi; Kajiura, Teruo. Bull. Chem. Soc. Jap.; 44: No. 11, 2921-5(Nov 1971).

The Raman spectra of β-uridine-5′-phosphoric acid (UMP), its deuterated product, β-uridine-3′-β-uridine-5′-phosphoric acid (U_pU), and polyribouridylic acid (poly U) have been observed in their aqueous solutions; and the Raman lines assignable to the phosphate group and to the base residue have been indicated. For UMP, the intensity ratio of a Raman line of the base residue versus that of the phosphate group was found to become greater on changing the exciting line from the 6328 Å line of a helium–neon laser

to the 4880 Å line of an argon ion laser. This fact has been taken as indicating that a preresonance Raman effect takes place of the base residue with the effective absorption at 2600 Å. (auth)

11641 SPECIFIC ACTIVITY OF SILICA SUPPORTED PLATINUM FOR THE CATALYSIS OF HYDROGEN–WATER DEUTERIUM EXCHANGE. Sagert, N. H.; Pouteau, R. M. L. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Can. J. Chem.; 49: No. 21, 3411-17(1 Nov 1971). (AECL–4004).

Some rate data are reported for deuterium exchange between water and hydrogen using a series of platinum–silica catalysts. Three different methods of preparing catalysts were used to give different series of metal particle sizes. Within each series, the particle size was increased by sintering batches in air, at temperatures up to 700°C. These methods produced platinum particles ranging from 5 to 250 Å in diameter. Metal surface areas and particle sizes were measured by hydrogen chemisorption, x-ray diffraction, and electron microscopy. The specific rates, i.e., rates per unit surface area of platinum varied by a factor of three within each series, reaching a maximum for sintering temperatures of about 500°C. These maximum rates, measured at 127°C with a water-to-hydrogen ratio of 0.31, varied from 1.9×10^{-8} to 5×10^{-8} mole D_2 cm^{-2} s^{-1}. Thus no effect of particle size on rate was observed, and the differences noted are ascribed to other effects of the methods of preparing the catalysts. (auth) (Canada)

11642 ISOTOPE EFFECTS IN THE MOBILITIES OF ^{40}Ca AND ^{45}Ca IN SOLUTIONS OF AMMONIUM CHLORIDE AND CITRIC ACID. Stepanova, N. D.; Stepanov, A. V. (Inst. of Tech., Leningrad). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 5, 643-4(May 1971).

Translated from Zh. Fiz. Khim.; 45: No. 5, 1148-50(May 1971).

The relative mobilities of calcium ions in solutions of ammonium chloride and citric acid were determined by an electromigration method. (auth)

11643 ISOTOPE EFFECT IN TEMPERATURE OF DEHYDRATION OF SOME ORGANIC COMPOUNDS. Gluzman, M. Kh.; Dashevskaya, B. I.; Kogan, V. S. (Kharkov Chemical-Pharmaceutical Scientific Research Inst. Physical-Technical Inst., Kiev). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 5, 644-5(May 1971).

Translated from Zh. Fiz. Khim.; 45: No. 5, 1151-3(May 1971).

The temperature of dehydration and the isotope effect are found to depend on the molecular mass of a polymer, its concentration in the solution, and the presence of electrolytes. (auth)

11644 BASIC HYDROLYSIS OF SOLUBILIZED OCTANE-2-DIAZOTATE. DISSECTION OF CONSERVATION AND EXCHANGE PATHWAYS. Moss, Robert A.; Fritz, Alan W.; Emery, Edgar M. (Rutgers–The State Univ., New Brunswick, N. J. Colgate-Palmolive Research Center, Piscataway, N. J.). J. Org. Chem.; 36: No. 25, 3881-5(17 Dec 1971).

Solubilized optically active octane-2-diazotate (^{16}O) in hexamethylphosphoric triamide–dicyclohexyl-18-crown-6 was hydrolyzed by slow addition to $H_2{}^{18}O$. The resultant 2-octanol was attributed to four product-forming pathways: ^{18}O-incorporation–retention, 18.9%; ^{18}O-incorporation–inversion, 58.5%; ^{16}O-conservation–retention, 16.5%; ^{16}O-conservation–inversion, 6.0%. The results are compared to those obtained upon direct addition of $H_2{}^{18}O$ to solid octane-2-diazotate; mechanisms are discussed. (auth)

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Refer also to abstracts 11572, 11864, 12640, 12641, 12643, 12754, 12759, 12765, and 14506.

11645 (ANL-Trans-905) SIGN OF THE ASTATINE ION IN $HClO_4$–$H_2Cr_2O_7$ SOLUTIONS. Tyung, Do Kim; Dudova, I.; Khalkin, V. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Argonne National Lab., Ill., from Russian Preprint, 6p. Dep. NTIS.

Results obtained on the electromigration of astatine show an obvious tendency of astatine to migrate to the cathode (-) after being oxidized with dichromate in perchloric acid solution. The relative amount of astatine found in the catholyte is not large: 5 to 10%. But the observed effect is clear in that all experiments with the oxidized form of astatine At(X) the anolyte remained practically inactive while the radioactivity of the catholyte reached 2 to 6×10^4 counts/min. It was concluded that in dilute aqueous $HClO_4$ solutions dichromate oxidizes the astatine and At(O) to a valence state, forming positively charged ions. (D.H.M.)

11646 (RT/CHI–(71)5) OSCILLOPOLAROGRAPHIC BEHAVIOUR OF ACTINIDE IONS IN OXALATE MEDIA. Casadio, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 14 Apr 1971. 8p. Dep. NTIS (U. S. Sales Only).

Behavior of the redox systems U(VI)–U(V); Pu(VI)–Pu(V); and Pu(IV)–Pu(III) at M.D.E. in oxalate media is obtained by direct and reverse linear sweep voltammetry. Peak potentials and diffusion coefficients for the oxidized species are reported. (auth)

11647 ON THE SUBJECT OF YU. P. DAVYDOV'S LETTER TO THE EDITOR OF THE JOURNAL RADIOKHIMIYA. Rozovskaya, N. G.; Ampelogova, N. I.; Ginzburg, F. L.; Sheidina, L. D. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 340-1(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 325-6(Mar-Apr 1971).

Studies on the colloidal nature of radioactive elements are discussed along with the equilibrium distribution of a radioactive element between the solid phase and the solution. (M.C.G.)

11648 FINE STRUCTURE OF THE ELECTRONIC SPECTRA OF HEPTAVALENT NEPTUNIUM. Chaikhorskii, A. A. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 311-13(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 302-5(Mar-Apr 1971).

The absorption spectra of solutions of neptunium are shown. They have a rather noticeable fine structure. The electronic vibrational and vibrational spectra of Np(VII) show its existence in the form of NpO_2^{3+}. (M.C.G.)

11649 ABSORPTION SPECTRA OF Am(III) IN STANDARD SOLUTIONS OF HCl. Barbanel, Yu. A.; Gorskii, A. G.; Kotlin, V. P. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 314-16(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 305-7(Mar-Apr 1971).

The absorption spectra of Am(III) in absolute ethanol with various HCl contents were studied. Three hypersensitive transitions were detected. (M.C.G.)

11650 CRYSTAL STRUCTURES OF POTASSIUM AND SODIUM MONOURANATES. Kovba, L. M. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 319-20(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 309-11(Mar-Apr 1971).

Polycrystalline samples of α-K_2UO_4 and β-Na_2UO_4 were photographed on a diffractometer with scintillation recording. Lattice parameters are given. (M.C.G.)

11651 OXIDE FLUORIDE SYSTEMS OF THORIUM AND URANIUM. IV. Fonteneau, Gilles; Lucas, Jacques (CNRS, Rennes, France). J. Inorg. Nucl. Chem.; 33: No. 12, 4061-7 (Dec 1971). (In French).

The system $ThOF_2$–UOF_2 was studied at 1100°C in sealed nickel tube: a solid solution $Th_{1-x}U_xOF_2$ was obtained for $x < 0.20$ and a destruction mechanism of the phase MOF_2 is proposed. The ternary system ThO_2–UO_2–UF_4, in which was found a miscibility domain of UF_4 in the solid solution $Th_{1-x}U_xO_2$, was studied. (auth)

11652 DIOXIDE OF ^{248}Cm. Peterson, J. R. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Fuger, J. J. Inorg. Nucl. Chem.; 33: No. 12, 4111-17(Dec 1971).

The dioxide of curium was prepared on the microgram scale with long-lived ^{248}Cm ($t_{\frac{1}{2}} = 3.5 \times 10^5$ yr) and found to exhibit the face-centered cubic, fluorite-type structure with an average, room-temperature lattice constant of 5.359 ± 0.002 Å. This value is significantly lower than all previously reported values, which is consistent with the contention that the earlier samples suffered from radiation-induced expansion. The curium(IV) ionic radius is calculated to be 0.880 Å. Plots of the actinide dioxide lattice parameter and tetravalent ionic radius vs atomic number do not show the half-filled ($5f^7$) electron subshell effect. (auth)

11653 APPLICATION OF RADIOISOTOPES TO TREATMENT OF WASTE WATER. Machi, Sueo (Japan Atomic Energy Research Inst., Takasaki). Genshiryoku Kogyo; 17: No. 8, 26-31(Aug 1971). (In Japanese).

Review is made on possible effects of irradiation, decrease of COD (chemical oxygen demand) and BOD, bactericidal effects, removal of chemicals, precipitation of sludges and promotion of filtration, sources and apparatuses used for irradiation, economy of treatment of water by irradiation, and examples of practical application of irradiation. COD decreases linearly with increasing dose of irradiation. The irradiation is also very effective in decreasing the concentration of microbes. The concentration of phenol and cyanide ions in waste water rapidly decreases with

increase of time of irradiation. The coagulation of particles in sludge is accelerated by the irradiation and results in rapid passage through filters. Application is being attempted in various fields such as breeding of chickens and the treatment of waste water from paper-making industries. Feed exhausted from hens with remaining nutritive value can be recovered by treatment with water and irradiation. (Japan)

11654 ECLIPSED AND STAGGERED CONFIGURATIONS FOR A METHYL-SUBSTITUTED CYCLO-OCTATETRAENYL DIANION COMPLEX OF URANIUM(IV): X-RAY DETERMINATION OF THE STRUCTURE OF $U[C_8H_4(CH_3)_4]_2$. Hodgson, Keith O.; Dempf, D.; Raymond, Kenneth N. (Univ. of California, Berkeley). J. Chem. Soc., D; No. 24, 1592-3(22 Dec 1971).

The crystal and molecular structure of bis-(1,3,5,7-tetramethylcyclooctatetraenyl)uranium(IV) was determined; the unusual crystal structure has two types of molecule with different rotomeric configurations around the two dianion rings on a central atom; in one form the methyl groups are approximately staggered and the other eclipsed. (auth)

11655 ISOPIESTIC MEASUREMENTS OF THE OSMOTIC AND ACTIVITY COEFFICIENTS FOR THE SYSTEMS $HClO_4 + UO_2(ClO_4)_2 + H_2O$ AND $NaClO_4 + UO_2(ClO_4)_2 + H_2O$ AT 25°C. Rush, R. M.; Johnson, J. S. (Oak Ridge National Lab., Tenn.). J. Chem. Thermodyn.; 3: No. 6, 779-93(Nov 1971).

Isopiestic results for the three-component systems $HClO_4 + UO_2(ClO_4)_2 + H_2O$ and $NaClO_4 + UO_2(ClO_4)_2 + H_2O$ and for the limiting two-component systems are presented. Analysis of the results by the neutral-electrolyte and ion-component methods gave equally satisfactory fits to the osmotic coefficients. Estimates of the three-component results from two-component results were better with the ion-component approach for $HClO_4 + UO_2(ClO_4)_2 + H_2O$, but were better with the neutral-electrolyte approach for $NaClO_4 + UO_2(ClO_4)_2 + H_2O$. (auth)

11656 X-RAY PHOTOELECTRON SPECTRA OF URANIUM(VI) COMPLEXES OF 8-HYDROXYQUINOLINE. Adams, D. B. (Univ. of Durham, Eng.); Clark, D. T.; Baker, A. D.; Thompson, M. J. Chem. Soc., D; No. 24, 1600-1(22 Dec 1971).

Molecular core binding energies were measured for $UO_2(C_9H_6NO)_2$, C_9H_7NO, $UO_2(C_9H_6NO)_2 \cdot C_9H_7NO$, and $C_9H_8NO^+Cl^-$; the results show the potential of x-ray photoelectron spectroscopy for the study of the binding of extra molecules of ligands in compounds of a similar composition to the 1:3 uranium(VI) complex and of other metal chelates in general. (auth)

11657 SOLVOLYSIS OF ORGANIC PHOSPHATES. IV. 3-PYRIDYL AND 8-QUINOLYL PHOSPHATES AS EFFECTED BY THE PRESENCE OF METAL IONS. Murakami, Yukito; Sunamoto, Junzo (Kyushu Univ., Fukuoka). Bull. Chem. Soc. Jap.; 44: No. 7, 1827-34(Jul 1971).

Influence of nickel(II), copper(II), and thorium(IV) ions on the hydrolysis of 3-pyridyl and 8-quinolyl phosphates was investigated at $\mu = 0.10$ in a lower pH region. The reaction in the presence of the bivalent metal ions followed apparent first-order kinetics with respect to the phosphates in homogeneous phase. The copper ion showed a positive catalytic effect only on the hydrolysis of 8-quinolyl phosphate, and such effect increased markedly as pH was raised. The nickel ion, however, did not show any significant effect on the hydrolysis of both phosphates. Complex formation of the phosphates with copper(II) and nickel(II) was studied by means of potentiometric measurements. The results strongly suggest the importance of preliminary chelate formation for yielding catalytic efficiency. The presence of the thorium ion resulted in a profound acceleration of hydrolysis of both phosphates in a relatively lower temperature range. The reaction rate did not follow the simple kinetic law although the reaction system was kept homogeneous under the present experimental conditions. The complex formation with the phosphate moiety, which would provide effective charge neutralization for the substrate, is most likely the necessary cause for the thorium catalysis. Plausible reaction mechanisms and the corresponding potential energy correlations were postulated for the present catalysis. (auth)

11658 CALORIMETRIC STUDY OF SOLID-STATE RADIATION POLYMERIZATION. I. POLYMORPHIC TRANSFORMATIONS OF SOLID ACRYLONITRILE. Kaplan, A. M.; Kiryukhin, D. P.; Barkalov, I. M.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 460-1(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

The polymorphic transformations of solid acrylonitrile (AN) was investigated with a diathermic calorimeter (of the Calvet type) of high sensitivity (10^{-6} cal/sec, with a persistence of about 1 min) over the temperature range 77 to 190°K. Experimental curves obtained during heating and cooling of AN specimens in the calorimeter are shown. A heat-evolution rate of 4.1×10^{-3} cal/sec over the temperature range 90 to 135°K, 2.6×10^{-2} cal/sec over the range 135 to 175°K, and 4.7×10^{-2} cal/sec over the range 175 to 200°K was obtained. When the AN was subjected to slow cooling (0.3 deg/min or less), solid AN could be produced in the form of a phase that is thermodynamically stable at low temperatures. Two transitions then occurred during heating to above 77°K: a reversible type 1 transition at 164°K with a heat of transition $Q = -300 \pm 20$ cal/mole and melting at 189°K with $Q = -1550 \pm 75$ cal/mole. During very rapid cooling of the AN (at a rate of more than 50 deg/min), an irreversible exothermic transition, crystallization of vitreous AN, occurs in the vicinity of 115°K. (M.C.G.)

11659 REACTION OF THORIA WITH ZIRCONIUM CHLORIDE. Kateley, J. A.; Tschetter, M. J.; Chiotti, P. (Ames Lab., Iowa). J. Less-Common Metals; 26: No. 1, 145-55(Jan 1972).

The reactions of high-density cylindrical sol-gel thoria pellets with zirconium chloride in KCl-58.5 mole % LiCl and in KCl-40.0 mole % $MgCl_2$ at 560 and 650°C were investigated. After a relatively short period the pellets become covered with an adherent but porous ZrO_2 product and thereafter the reaction is controlled by the diffusion of zirconium ions through fused salt channels in the scale. Reaction rate constants for the initial period and for the diffusion-controlled period were determined. An equation for diffusion through a general cylindrical scale or surface during reaction was derived and employed to calculate the time required for complete reaction. The data show that if a means is provided for preventing the zirconia product from adhering to the surface, relatively large pellets, 0.344 cm long and 0.592 cm diam., react completely in 8 to 38 hr in the above temperature range. With an adherent scale the time required is much longer. The rate is significantly more rapid in the KCl-$MgCl_2$ salt. The reaction was not sensitive to the presence of a reducing agent or the stirring rates employed. (auth)

11660 THERMOCHEMICAL STUDIES ON THE COMPLEXES OF THE URANYL ION. Newbery, J. E. (University Chemical Lab., Canterbury, Eng.). pp 301-4 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

The use of the spectrochemical series, hardness and softness of donors, and displacement series in estimating the strength of bonding between the uranyl ion and a variety of ligands were studied. Data are tabulated for the formation of uranyl chloride, bromide, sulfate, and thiocyanate. (P.C.H.)

11661 LOW-TEMPERATURE ABSORPTION SPECTRUM OF URANIUM(3+) FORMATE. ENERGY LEVEL SCHEME OF URANIUM(3+). Drozdzynski, Janusz; Conway, John G. (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 2, 883-91 (15 Jan 1972).

The absorption spectrum of thin films of $U(HCOO)_3$ was measured at 298, 77, and 4°K in the range 4000 to 24,000 cm^{-1}. Electrostatic, spin-orbit, and configuration-interaction parameters were obtained by least-squares fitting to 12 observed levels for $U(HCOO)_3$. The obtained parameter values (in cm^{-1}) are: $E^1 = 2779$, $E^2 = 14.1$, $E^3 = 271.6$, $\zeta_{5f} = 1656.4$, $\alpha = 17.5$, $\beta = -479$, $\gamma = 1000$. A good agreement with experiment is observed for all calculated levels and a number of new assignments of excited levels of U(3+) are proposed. Intensity calculations were carried out and considered in the problem of level assignment. (auth)

11662 STRUCTURE AND CONFORMATION OF Th(IV)-COMPLEXES OF ETHYLENEDIAMINETETRAACETIC ACID AND ITS ANALOGS IN AQUEOUS SOLUTION. Fried, Albert Robert Jr. College Station, Tex.; Texas A and M Univ. (1971). 106p. University Microfilms Order No. 71-24,669.

Thesis.

The thorium(IV) complexes of ethylenediaminetetraacetic acid (EDTA), diethylenetriaminepentaacetic acid (DTPA), triethylenetetraminehexaacetic acid (TTHA), and N-hydroxyethylethylenetriaacetic acid (HEDTA) were studied in aqueous (D_2O) solutions as a function of "a" value (a = moles of base added per mole of ligand or chelate). On the basis of aqueous (D_2O) infrared and proton nuclear magnetic resonance spectra of these Th(IV) complexes, reasonable solution structures are proposed and compared with structures suggested on the basis of previous potentiometric studies. The presence or absence of various NMR splitting patterns was used to determine qualitatively the lability of individual thorium-ligand bonds. The simple NMR spectra obtained for the Th(IV)-EDTA chelate are indicative of the short lifetimes of the thorium-EDTA bonds. Th(IV) ion begins to hydrolyze the $Th(OH)_4$ above pD 10 in the Th(IV)-EDTA chelate, whereas, hydrolysis of

Th(IV) ion in the more stable Th(IV)–DTPA complex does not occur until pD > 12.3. Potentiometric data gave no evidence for the formation of 1 : 2 or 2 : 3 Th(IV)–EDTA complexes when the appropriate molar ratios of metal to ligand were used. NMR data for intermolecular ligand exchange of 1 to 2 molar ratios of Th(IV) ion to EDTA revealed a slower exchange rate for the monoprotonated free ligand as opposed to the deprotonated free ligand, under the same solution conditions. The slower intermolecular exchange rates exhibited by the more protonated form of EDTA were interpreted as the ability of a proton on a nitrogen atom to hinder formation of the thorium–nitrogen bond. Unlike the 10^{-3} M potentiometric study of Th(IV)–DTPA at a = 0, the 0.10 M ir and NMR spectra confirm the presence of a 1 : 1 complex in which DTPA has a free (uncoordinated) iminodiacetic acid group. In the 1 : 2 Th(IV)–DTPA system separate NMR resonances for coordinated and free DTPA were observed over the entire pD and temperature range studied. This confirmed that the intermolecular exchange kinetics is relatively slow on the NMR time scale. The successive protonation steps of the anion of TTHA were deduced from the chemical shifts of ligand NMR resonances and from the intensities of the various types of carboxyl infrared bands. In the Th(IV)–TTHA system, protonated complexes were found to exist at low pH. Above pH 1.47 (a = 4) the extremely stable [Th(IV)–TTHA] chelate predominates and multiplet NMR splitting patterns are observed. Isotopic exchange of specific acetate protons with solvent deuterium at high pD and elevated temperature provided additional evidence for the existence of a single geometrical isomer of the Th(IV)–TTHA complex. Investigation of the Th(IV)–HEDTA system indicates that the polynuclear species formed above pH 5 are exceptionally resistent to hydrolysis of Th(IV) ion to $Th(OH)_4$ even at pD values of 13.0. These data along with the previously proposed cyclic structure of the hexanuclear species are explained by postulating ligand dissociation from the polynuclear species at high pH, leaving an octahedral cage of Th(IV) ions further complexed by hydroxide ions, and possibly linked by hydroxo and oxo bridges. Recent work supporting this structure is discussed. (Diss. Abstr. Int., B)

11663 BIS(1,3,5,7-TETRAMETHYLCYCLOOCTATETRAENE)URANIUM(IV) AND BIS(1,3,5,7-TETRAMETHYLCYCLOOCTATETRAENE)NEPTUNIUM(IV). PROTON MAGNETIC RESONANCE SPECTRUM AND THE QUESTION OF f-ORBITAL COVALENCY. Streitwieser, A. Jr. (Univ. of California, Berkeley); Dempf, D.; La Mar, G. N.; Karraker, D. G.; Edelstein, N. J. Amer. Chem. Soc.; 93: No. 26, 7343-4(29 Dec 1972).

The proton NMR spectrum of THF-d_8 solution of bis(1,3,5,7-tetramethylcyclooctatetraene)uranium was recorded as a function of temperature. Two peaks with intensities of 3 : 1 were observed and can be assigned to the methyl and ring protons, respectively. The proton NMR spectrum of a toluene-d_8 solution of bis(1,3,5,7-tetramethylcyclooctatetraene)neptunium was recorded at 37°C. The corresponding proton peaks of the methyl group (line width ~300 Hz) and ring (line width ~2000 Hz) were much broader than for the U complex. (D.H.M.)

11664 THEORETICAL PREDICTIONS OF THE CHEMISTRY OF SUPERHEAVY ELEMENTS. CONTINUATION OF THE PERIODIC TABLE UP TO Z = 184. Fricke, B.; Waber, J. T. (Northwestern Univ., Evanston, Ill.). Actinides Lanthanides Rev.; 1: No. 5, 433-85(Sep 1971).

Research on prediction of the chemical behavior of elements beyond 105 is summarized. The physical and chemical bases for these predictions are discussed. The electron configuration, ionization energies, and radii of the 6d transition series E104 to E112, the 7p and 8s elements E113 to E120, the 5f and 6g elements E121 to E154, E156 to E172, and E184 are described. (55 references). (M.C.G.)

11665 PAPER ELECTROPHORESIS OF COMPLEX COMPOUNDS OF FORMALDOXIMS WITH METALS. II. INVESTIGATION WITH METAL COMPLEXES. Becka, J.; Jokl, V. (Landwirtschaftliche Hochschule, Brno, Komensky Univ., Bratislava). Collect. Czech. Chem. Commun.; 36: No. 9, 3263-74 (Sep 1971). (In German).

Experimental results are presented on paper electrophoresis of formaldoximates formed with 27 metals. The electrophoretic mobility of defined ions of manganese, nickel, and iron formaldoximates was a tool for calculating the relationship between electrophoretic equivalence mobility and molecular weight of the ion to be investigated under the defined conditions. After this relationship was established, it was used to determine the molecular weight of additional ions. From the course of the curve of the electrophoretic mobility, the pH values at which the individual complexes existed, the charge of the complexes, and the approximate values of some stability constants were determined. (tr-auth)

11666 COMMENTS ON THE HIGH-RESOLUTION PHOTOELECTRON SPECTRUM OF H_2O AND D_2O. Asbrink, L. (Royal Inst. of Tech., Stockholm); Rabalais, J. W. Chem. Phys. Lett.; 12: No. 1, 182-4(1 Dec 1971).

The photoelectron spectra of H_2O and D_2O have been measured with sufficient resolution to partially resolve rotational structure. The similarity between the band resulting from the photoelectron transition to the ground ionic state, $^2B_1$, and one of the molecular Rydberg transitions is discussed. Some of the factors effecting the resolution in photoelectron spectroscopy are presented. (auth)

11667 LUMINESCENT CHARACTERISTICS OF URANIUM COMPOUNDS. Alikhanova, Z. M.; Burkov, V. I.; Ivanova-Korfini, I. N.; (and others). Zh. Prikl. Spektrosk.; 15: No. 2, 249-54(Aug 1971). (In Russian).

The polarized spectra of a group of luminescing U propionates of the type $M[UO_2(C_2H_5COO)_3]$ were investigated, where M was K, Rb, Cs, or NH_4. The polarized luminescence spectra recorded at 300 and 77°K, proved to be extremely similar among the four U propionates and to that of sodium uranyl acetate. The spatial configurations of these five compounds are diagrammed and discussed with respect to an apparent identity in molecular and crystal structure. The spectral characteristics were also studied in relation to deformation of the uranyl complex. (K.S.W.)

11668 ENVIRONMENT OF IONS IN AQUEOUS SOLUTION. Saluja, Preet Pal Singh. Philadelphia; Univ. of Pennsylvania (1971). 221p. University Microfilms Order No. 71-26,080. Thesis.

Work was carried out to extend and deepen the model of the solvent sheath near ions in aqueous solutions. The experimental measurements were those of compressibility of the solution. A modification of a method developed earlier was used to give measurements of sound velocity at frequency of 5 MHz to an accuracy of ±0.4 meter sec^{-1}. The velocity measurements were converted to values of the compressibility, β. Measurements were made with chlorides of lithium, sodium, potassium, rubidium, cesium, barium, calcium, strontium, magnesium, cerium, and thorium and with all halides of sodium and barium. The individual solvation numbers were found to be: $Li^+ = 4.0$, $Na^+ = 4.5$, $K^+ = 3.5$, $Rb^+ = 3.0$, $Cs^+ = 2.5$; $Ba^{+2} = 11.0$, $Ca^{+2} = 9.0$, $Sr^{+2} = 9.0$, $Mg^{+2} = 10.0$; $La^{+3} = 15.0$, $Ce^{+3} = 18.0$; $Th^{+4} = 22.0$; $F^- = 4.0$, $Cl^- = 2.0$, $Br^- = 1.8$, and $I^- = 1.5$. The meaning of the compressibility and the ionic vibration potential measurements are discussed. The basic assumption of the method, that molecules oriented to the ion are much less compressible than those which are coordinated but still, "part of the solvent structure," is supported numerically. Changes in the simple Passyanski calculation arising from residual compressibility are calculated. The model that shows the greatest consistence with experiment has a first shell in which 2 types of water exist; a second shell, 1 molecule thick, consisting primarily of monomers, some of which librate with respect to the first shell. The model of bulk water used was a mixture model consisting of monomeric waters among clusters of 30 to 40 water molecules. (Diss. Abstr. Int., B)

11669 ELECTROCHEMICAL MEASUREMENT OF THE SOLUBILITY OF CARBON IN SODIUM. Salzano, F. J.; Newman, L. (Brookhaven National Lab., Upton, N. Y.). Nucl. Technol.; 13: No. 3, 289-96(Mar 1972).

The solubility of carbon in sodium was measured with an electrochemical carbon meter by measuring the change in emf when known amounts of carbon were added to sodium contained in a nickel vessel. The solubility, C_o, in ppM is given by the expression, $\log_{10} C_o$ (ppM) = $-[2440]/[T(°K)] + 3.70$. The data show little scatter, were easy to reproduce, and were not dependent on the rate of addition or the initial concentration of carbon. The results obtained are compared to the measurements reported in other investigations. The relation between the solubility data and the phenomenon of mass transport of carbon in sodium–stainless steel systems is discussed. Oxygen was found to have no effect on the solubility of carbon in the concentration range from one to 240 ppM. When nitrogen is present at one atmosphere pressure over the sodium, it acts as a sink for carbon. (auth)

11670 PROPERTIES OF URANIUM(IV) DICHLOROACETATE. Lobanova, T. S.; Ivanov, A. V.; Dunaeva, K. M. Zh. Neorg. Khim.; 16: No. 7, 2033-4(Jul 1971). (In Russian).

The synthesis of uranium(IV) dichloroacetate was accomplished by dissolving UO_3 in dichloroacetic acid. The product had a density of 1.79 g/cm^3 at 20°C and was readily soluble in H_2O, alcohol, mineral acids, and some organic solvents. Heating in the presence of O_2 transformed $U(CHCl_2COO)_4$ into $UO_2(CHCl_2COO)_2$ and then into UO_2Cl_2. (K.S.W.)

11671 SPECTROPHOTOMETRIC INVESTIGATION OF NITRATE COMPLEXES OF RARE EARTHS IN ACETONE SOLUTIONS. Poluektov, N. S.; Efryushina, N. P. (Inst. of General and Inorganic Chemistry, Odessa). Ukr. Khim. Zh.; 37: No. 7, 697-700(Jul 1971). (In Russian).

Formation of complexes of the ions Pr^{3+}, Nd^{3+}, and Er^{3+} with nitrate ions in acetone solutions was investigated by the use of absorption spectra in the range 440 to 610 nm. Spectrophotometric examination showed that the addition of certain bases (diphenylguanidine or 2,2′-dipyridine) or $LiNO_3$ to a solution of a rare earth nitrate or perchlorate in acetone induced specific changes in the absorption spectra. From these data the molar coefficients of absorption and the equilibrium constants of complex formation for Nd and Er were computed. (K.S.W.)

11672 EMPIRICAL FORMULA FOR THE OPTIMUM CONCENTRATION FOR HYDROTHERMAL PRECIPITATION. Katsurai, Tominosuke (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 44: No. 11, 3207(Nov 1971).

The equation $T = T_0 + \alpha(r - r_0)^2$ where T = temperature at which onset of turbidity takes place, T_0 = the lowest temperature at which onset of turbidity takes place, r = distance between solute particles, r_0 = the value of r corresponding to T_0, and α = constant is given for understanding the process of hydrothermal precipitation, since there seems to be no theory on hydrothermal precipitation to afford an explicit formula for the relation between r and T. Examples are given for aqueous solutions of $AlCl_3$, $Ce(NH_4)_2 \cdot (NO_3)_6$, $ThCl_4$, and $Th(NO_3)_4$. (P.C.H.)

11673 THERMAL STABILITY OF $K_4Th(C_2O_4)_4.4H_2O$ AND $Na_4Th(C_2O_4)_4.5,5H_2O$. Molodkin, A. K.; Balakaeva, T. A.; Kuchumova, A. N. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 16: No. 7, 1892-4(Jul 1971). (In Russian).

The thermal stability of two oxalate compounds of Th was investigated: $K_4Th(C_2O_4)_4 \cdot 4\ H_2O$ and $Na_4Th(C_2O_4)_4 \cdot 5.5\ H_2O$. Dehydration of the compounds consisted of two processes: removal of water in two steps and reorganization of the hydrate structure into an anhydrous structure. Transition of the metastable to the stable state was accomplished by evolution of heat. The ir absorption spectrum that represented the oxalate group vibrations showed no change. The final pyrolysis products were ThO_3 and K_2CO_3. (tr-auth)

11674 REACTIONS OF ION EXCHANGERS WITH SALTS OF LOW SOLUBILITY. KINETICS AND EQUILIBRIA. Bunzl, Kurt (Gesellschaft fuer Strahlen- und Umweltforschung Munich mbH, Neuherberg, Ger.). Z. Phys. Chem. (Frankfurt); 75: No. 3-4, 118-36(Aug 1971).

The kinetics of dissolution of a slightly soluble salt by an ion exchanger was measured by dissolving $SrSO_4$, $SrCO_3$, and TlI by a cation exchanger in the Na^+ form and $SrSO_4$ as well as $SrCO_3$ by an anion exchanger in the Br^- form. In an agitated solution the rate determining step is interdiffusion of the ions in the Nernst film surrounding the ion exchanger particle. By means of the theory of irreversible thermodynamics, a relation describing the rate of a film-diffusion-controlled ion exchange process involving arbitrary valent ions was derived. This equation, which allows for the diffusion potential as well as for the selectivity of the ion exchanger was then solved under the boundary and initial conditions of the system. The theory explains the dependence of the dissolution rate on the solubility product of the salt, on the selectivity of the ion exchanger and on the set of four diffusion coefficients, describing isothermal diffusion in the corresponding ternary electrolyte solution. All these quantities can be determined by independent measurements. (auth)

11675 DENSITY, VISCOSITY, AND SURFACE TENSION OF URANIUM TETRAFLUORIDE. Kulifeev, V. K.; Panchishnyi, V. I.; Stanolevich, G. P. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 3, 92-4(1971). (In Russian).

The density of UF_4 was determined by hydrostatic suspension from 1,388 to 1,628°K, and may be expressed by $\rho = 7.469 \times 10^{-4}$ T g/cm^3. The kinematic and dynamic viscosities of UF_4 over essentially the same temperature range were determined. The dynamic viscosity was 2.460 and 1.122 centipoises at 1,338 and 1,618°K, respectively. The surface tension as measured by the resting drop method may be expressed by $\sigma = 186 - 4 \times 10^{-2}$ T dyne/cm over the range 1,325 to 1,560°K. (K.S.W.)

11676 STABILITY CONSTANTS OF THE MONOCHLORO COMPLEXES OF Bk(III) AND Es(III). Harmon, H. D. (Univ. of Tennessee, Knoxville); Peterson, J. R.; McDowell, W. J. Inorg. Nucl. Chem. Lett.; 8: No. 1, 57-63(Jan 1972).

Earlier work on the chloro complexes of Pu(III), Am(III), and Cm(III) is first briefly summarized. In the studies on Bk(III) and Es(III) a solvent extraction technique was employed to study complex formation in $NaCl-NaClO_4$ solutions at ionic strength 1.0 and pH 2.0, and the reported stability constants are stated to be the first reported for the monochloro complexes. The solvent employed was bis(2-ethylhexyl) phosphate (DEHPA) in toluene, and the isotopes ^{249}Bk and ^{253}Es were used. Details are given of the extraction procedure and analytical methods, together with calculations of the extraction coefficients and stability constants. Results indicated the presence of only the monochloro complexes in the Cl^- concentration range up to 1.0 M. No significant change was observed in the stability or structure of the monochloro complexes of the trivalent actinides with increase in atomic number and the complexes were weak and of the outer-sphere type. (UK)

Radiation and Nuclear Chemistry

Refer also to abstracts 11854, 11905, 13575, 14081, and 14225.

11677 (BARC-489) PROCEEDINGS OF THE SYMPOSIUM ON RADIATION CHEMISTRY, TROMBAY, FEBRUARY 7, 1970. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 171p. (CONF-700214).

An abstract was prepared for each of the 19 papers included. (M.C.G.)

For abstracts of individual papers see: 11682-11686, 11729, and 11768-11780.

11678 DEVELOPMENT OF THE CHEMICAL INDUSTRY IN CONNECTION WITH NUCLEAR POWER INDUSTRY. Wakasa, Ryoichi; Oizumi, Chihiro (Asahi Chemical Industry Co. Ltd., Osaka). Nenryo Kyokai-shi; 50: No. 531, 550-61(Jul 1971). (In Japanese).

The chemical industry in the future as related to the nuclear power industry is considered from two standpoints: chemical industry that uses nuclear power as the main energy source and chemical industry that is considered as a part of nuclear power industry. In connection with these standpoints market prospects of the nuclear fuel system, especially the nuclear fuel reprocessing industry in Japan, are described. (auth) (Japan)

11679 INFLUENCE OF MORPHOLOGICAL FACTORS ON INDUCED RADICALS IN IRRADIATED POLYETHYLENE SINGLE CRYSTALS. Kusumoto, Naoshi; Yamamoto, Tateo; Takayanagi, Motowo (Kyushu Univ., Fukuoka). Mem. Fac. Eng., Kyushu Univ.; 30: No. 3, 87-99(Mar 1971).

Polyethylene single crystals both as-grown and annealed with different lamellar thickness were irradiated by γ rays to a dose of about 10^7 rad at liquid nitrogen temperature in vacuo, and then ESR measurements were made. In the as-grown crystals alkyl radicals were concentrated at the surface. For the annealed crystals, the radical concentration was greater than in the original crystals because of an increase in disorder with annealing. By assuming that the crystals form blocks on annealing and that the surface and the interior of the blocks have the same trapping capacities for radicals as in the original crystals, the dependence of the size of the blocks on variation in annealing temperature and the original lamellar thickness was estimated. This estimate was supported by the theory of the thickening process of single crystals. Two types of radical reactions with different reaction rates were found to occur simultaneously when specimens were annealed above room temperature. The rapid process was independent of the lamellar thickness and was related to the reaction of radicals mainly in the surface region and the defects within the crystals. The slow process was strongly dependent on the lamellar thickness (i.e., the reaction rate was much depressed as the lamellar thickness was increased), and was inferred to be closely related with molecular motions manifested in viscoelastic measurements by the crystalline dispersion α_c. (auth) (Japan)

11680 EFFECTS OF THE VALUE OF LET ON THE RADIOCHEMICAL PROCESSES OF CROSS-LINKING AND DEGRADATION OF SOME POLYMERS. Zverev, A. B.; Lavrentovich, Ya.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 453-4 (Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

The effect of LET on the processes of crosslinking of polystyrene and degradation of poly(methyl methacrylate) and cellulose diacetate was studied. Hard films of different thicknesses were subjected to the action of ^{60}Co γ rays, 14-MeV deuterons, and 28-MeV α particles. The irradiation was carried out in vacuum (10^{-3}

to 10^{-4} Torr) at a temperature not exceeding 30°C at dose rates from 1500 to 3000 rad/sec. In the case of polystyrene and poly(methyl methacrylate) the track structure of the charged particle had considerable effect on the processes of crosslinking and degradation. Thus, in irradiating polystyrene with ^{60}Co γ rays, the dose at which the gel fraction appeared is approximately equal to 7 Mrad. As the value of LET increased, the gel formation dose fell rapidly. The radiation yield of the crosslinks increased sharply. Poly(methyl methacrylate) underwent effective degradation at doses up to 16 Mrad. The degradation was less effective under the action of deuterons and α particles than under that of γ radiation. The irradiation of cellulose diacetate showed that the LET value had practically no effect on the degree of degradation of this polymer. The molecular weight of the polymer was a linear function of dose in the 5 to 40 Mrad range. (M.C.G.)

11681 DISTRIBUTION OF ABSORBED ENERGY FOR ^{60}Co γ-RADIATION IN AN ORGANIC COMPOUND IN CONTACT WITH METALS AND QUARTZ. Verkhgradskii, O. P.; Chervetsova, I. N.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 444(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

The basic characteristics are examined for the division of absorbed ^{60}Co γ radiation energy among the components of a heterogeneous system differing in their dosimetric properties (effective atomic number, electron density, stopping power for charged particles). The distribution of absorbed doses was studied for organic compounds in contact with plates of aluminum, copper, zinc, lead, gold, and quartz of various thicknesses. Also investigated was the change in dose size in organic compounds as a function of the orientation of the boundary layer relative to the direction of propagation of the primary radiation. The absorbed dose was determined from the change in optical density of cellulose triacetate films. The dose absorbed in an organic compound near the boundary layer was 1.5 to 2 times larger than the dose in a homogeneous system irradiated under identical conditions. As a rule in the systems studied, the size of the dose decreased monotonically with increasing distance from the boundary layer, approaching the dose level for a homogeneous organic compound. An exception was found in the curves obtained for irradiation of the organic compound through a support of a material with low or medium atomic number (quartz, aluminum, copper, and zinc), for which a minimum was observed with a distance of 100 to 200 μ from the boundary layer. A comparison was made between the experimental data and calculations, and the reasons for the discrepancy between them are discussed. The γ energy absorbed by the organic substance in a heterogeneous system depends on the material and thickness of the support, on the direction of irradiation, and on the distance from the boundary layer. (auth)

11682 CURRENT STATUS AND FUTURE OF RADIATION CHEMISTRY. Hart, E. J. (Argonne National Lab., Ill.). pp 1-8 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC-489; CONF-700214.

The history of radiation chemistry, transient species chemistry, and future research in the field are discussed. (M.C.G.)

11683 PRIMARY PROCESSES IN RADIATION CHEMISTRY. Rama Rao, K. V. S.; Moorthy, P. N. (Bhabha Atomic Research Centre, Trombay, India). pp 9-27 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC-489; CONF-700214.

Theoretical and experimental investigations of the primary processes in radiation chemistry are discussed. Ionization and excitation events that yield free radicals and solvated electrons are considered. Ionic processes predominate in polar solvents and have a diminished role as the medium becomes nonpolar. (M.C.G.)

11684 PRIMARY SPECIES INVOLVED IN THE ENERGY TRANSFER FROM GAMMA IRRADIATED ALKALI HALIDES AND OTHER SOLIDS TO WATER: POSSIBLE INVOLVEMENT OF TRIPLET STATE OF WATER. Mittal, Jai P. (Bhabha Atomic Research Centre, Trombay, India). pp 40 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC-489; CONF-700214.

11685 SECONDARY PROCESSES IN RADIATION CHEMISTRY. Mittal, Jai P. (Bhabha Atomic Research Centre, Trombay, India). pp 41-68 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC-489; CONF-700214.

Late processes in radiation chemistry that lead to net chemical effects are considered. The processes in which positive ions take part immediately after ionization, ion-molecule reactions in the condensed phase, and charge neutralization are discussed. (M.C.G.)

11686 EXPERIMENTAL TECHNIQUES. Iyer, R. Mahadeva (Bhabha Atomic Research Centre, Trombay, India). pp 109-14 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC-489; CONF-700214.

Methods of studying reaction mechanisms in radiation chemistry are discussed. Intercepting a possible reaction to see the effect of such an interception on the final products, uses of ion scavengers, application of electric or magnetic fields to the system, and matrix isolation methods are described. (M.C.G.)

11687 FREE-RADICAL INTERMEDIATES IN THE REACTION OF THE HYDROXYL RADICAL WITH DIALKYL SULFOXIDES. Taniguchi, Hitoshi; Takagi, Hideo; Hatano, Hiroyuki (Kyoto Univ.). J. Phys. Chem.; 76: No. 1, 135-8(6 Jan 1972).

Since the hydroxyl radical is one of the active species formed in the radiolysis of water and plays a positive role in the radiation damage to organic solutes, it was considered of interest to investigate the intermediate radicals in the reaction of the hydroxyl radical with methionine in order to elucidate the process of the decomposition of dialkylsulfur compounds induced by irradiation in aqueous solutions. ESR studies of the free radicals produced in the reaction of the hydroxyl radical with methionine and related sulfur compounds are reported in which the hydroxyl radical was generated chemically in a $Ti^{3+}-H_2O_2$ system. (D.H.M.)

Radiation Effects

11688 RADIATION-INDUCED REDUCTION OF NITRATE IONS IN AMMONIA SYSTEMS. Sarrach, D. (Zentralinstitut fuer Isotopen- und Strahlentechnik, Berlin). Isotopenpraxis; 7: No. 7, 308-9(Jul 1971).

The yields of nitrite in deaerated solutions of potassium nitrate in the presence of 0.2M ammonia, 0.2M methanol, or both after irradiation with ^{60}Co γ radiation were determined. (M.C.G.)

11689 EFFECT OF PRIOR IRRADIATION ON THE THERMAL DECOMPOSITION OF AMMONIUM PERCHLORATE. Zakharov, Yu. A.; Isaev, R. N.; Nevostruev, V. A.; Vakhovskaya, L. A. (Tomsk Polytechnical Inst., USSR). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 443(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

The thermal decomposition of ammonium perchlorate subjected to prior irradiation with x-rays at 0.18 MeV, accelerated protons at 5 MeV, and neutrons obtained from the reaction $_4Be^9(d,n)_5B^{10}$ was studied by differential thermal analysis and derivatography. The rate of heating of the samples was 4 deg/min. The gaseous products at different degrees of decomposition were determined by mass spectrometry. An increase in the rate of decomposition was observed immediately after modified transition during preliminary irradiation by all forms of radiation up to doses of 10^{19} eV/g. Increasing the absorption dose up to approximately 10^{20} eV/g caused the salt to begin decomposing before the modified transition, i.e., near 235°C. In the process, the rate of decomposition at 235°C increased with increasing dose. Parallel to this, the rate of decomposition at 275°C (after the point of modified transition) decreased. The total amount of ammonium perchlorate decomposing at these temperatures was independent of dose and amounted to approximately 30%. The chief products of decomposition in the solid phase were chlorine, chloride, and chlorine dioxide. Chlorate, formed during irradiation of ammonium perchlorate, was virtually absent, even at temperatures above the decomposition temperature. In addition, chlorate decomposes to perchlorate at room temperature. Irradiation causes a significant increase in the fraction of ammonium perchlorate decomposing within the crystals rather than on the surface. Acceleration of the low-temperature thermolysis of the irradiated salt was due to the presence of radiolysis products. These may be designated as perchloric acid and molecular chlorine, and not chlorate, as was previously assumed. The high-temperature decomposition of NH_4ClO_4 (above 300°C) was less sensitive to irradiation, since in this temperature range perchlorate becomes free of large amounts of radiolysis products and fundamental radiation perturbations of the lattice. (auth)

11690 RADIATION-INDUCED ELECTRICAL CONDUCTIVITY OF POLYETHYLENE. Vaisberg, S. E.; Sichkar, V. P.; Karpov, V. L. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 454-5(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

The radioinduced electric conductivity of polymers (particularly polyethylene) is interpreted with the help of the Fowler-Rose model, which is based on n-type (or p-type) conductivity and includes not only the radiative generation of free current carriers and their recombination with stabilized charges of opposite signs but also the thermal equilibrium of the carriers between the conductivity band and the traps distributed exponentially in energy in the forbidden band. The electric conductivity of polyethylene (high-pressure) induced under the action of ^{60}Co γ rays was measured as a function of intensity and temperature. For the temperature dependence of the radioinduced electric conductivity of polyethylene, a straight line in the coordinates $\log \sigma - T$ with slope ~0.010 to 0.012 deg^{-1} was found. Some unimportant distortions of the straight line correspond to those temperature ranges in which heat-stimulated current peaks are observed. (M.C.G.)

11691 RADIOTHERMOLUMINESCENCE OF SOME POLYMERS IRRADIATED IN LIQUID HELIUM. Aulov, V. A.; Sukhov, F. F.; Slovokhotova, N. A.; Chernyak, I. V. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 452(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

Study of radiothermoluminescence (RTL) of polymers irradiated in liquid helium was continued. Low-density polyethylene (LDPE), high-density polyethylene (HDPE), isopolypropylene (PP), polytetrafluoroethylene (PTFE), polytrifluoroethylene (PTriFE), and polystyrene (PS) were studied. The irradiation was performed with a γ source in a specially designed cryostat. The dose rate was 550 R/sec. The luminescence for LDPE, HDPE, PP, and PS starts at 40°K and reaches a maximum at 100 to 120°K (δ-maximum), i.e., in the same temperature range in which defreezing of molecular mobility of phenyl radicals in the case of PS and methyl radicals in the case of PP and LDPE (δ-transition) was formed. Such a maximum could not be found in the case of PTFE and PTriFE. For PS the δ-maximum was the only one on the RTL curve, while for the other polymers another maximum was observed when the sample devitrified (β-maximum). In the case of LDPE, the luminescence at the δ-maximum was studied in greater detail. Exposure of irradiated samples to unfiltered light led to a sharp decrease in the intensity of the δ-maximum (whitening), while prolonged exposure to darkness at 4°K had no appreciable effect on the RTL curve. This shows that the δ-maximum, as well as the β-maximum, is due to photon emission by the electron-excited molecules formed when electrons recombine with cations. Exposure of irradiated samples to light with $\lambda > 800$ nm did not substantially change the sum of light at the δ-maximum. Consequently, the depth of the traps in which the electrons responsible for luminescence at the δ-maximum are stabilized is not less than 1 eV. Electrons cannot free themselves from these traps owing to the thermal energy at the temperature of this maximum. Therefore, the electrons are liberated when the traps are destroyed or owing to motion with them as a result of the appearance of molecular motion. The dependence of luminescence intensity on irradiation dose is different at the β- and δ-maxima. If the δ-maximum rises monotonically up to 6 Mrad, then the luminescence at devitrification reaches a maximum at 1 to 2 Mrad and then falls rapidly. This can be explained if it is assumed that the electrons responsible for luminescence at the δ-maximum are stabilized closer to the cation with which they recombine subsequently than the electrons that are responsible for luminescence at the β-maximum. This assumption is in agreement with the following facts: slower whitening of the δ-maximum, compared to the β-maximum; and appearance of luminescence in the 40 to 180°K range in samples, which, after irradiation, were heated to 180°K, cooled to 4°K, and whitened at this temperature. The latter result confirmed the redistribution of electrons in the traps under the action of visible light. (auth)

11692 EFFECTS OF DIFFERENT TYPES OF IONIZING RADIATION ON LOW-DENSITY POLYETHYLENE. Lavrentovich, Ya. I.; Yakimenko, G. S.; Staren'kii, A. G.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 464-5(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

The influence of the LET on the formation of the gel fraction and trans-vinylene double bonds and on the rupture of the vinylidene double bonds in low-density polyethylene was studied. Polyethylene films 0.1 to 0.2 mm thick were exposed to ^{60}Co γ radiation, deuterons with an energy of 14 MeV, and α particles with an energy of 28 MeV. The calculated LET for these types of radiation in polyvinylene was 0.2, 7.6, and 30 keV/μ, respectively. Irradiation was carried out in a vacuum (10^{-3} to 10^{-4} mm Hg) at room temperature and dose rates of 1500 to 5000 rad/sec in all cases. Experiments showed that the rate at which the vinylidene bonds were ruptured at doses below 20 Mrad, the rate at which the gel fraction was formed, and the rate at which trans-vinylene bonds were formed at doses below 100 Mrad were independent of the LET. At doses above 100 Mrad, γ radiation was less effective in inducing formation of trans-vinylene bonds than deuterons or α particles. A small difference in the residual vinylidine-bond concentrations under the action of γ rays and heavy charged particles was detected. Experiments demonstrated that migration of charge and excitation over the aliphatic chain plays a large role in polyethylene during the physical stage of radiolysis. Localization of charges at the vinylidene bonds and subsequent reactions by the mechanism described by Dole et al., and Auerbach result in formation of cross linkages and radicals and rupture of the vinylidene double bonds, while trans-vinylene double bonds develop when the excitation is deactivated in the center of the chain. Track effects influence the formation rate of trans-vinylene bonds at large doses, where the chemical structure of the polyethylene is altered. Radical reactions play a larger role in this case, their course being influenced by the structure of the ionizing-particle track. (auth)

11693 ELECTRON SPIN RESONANCE AND ENDOR STUDIES OF RADIATION-PRODUCED RADICAL PAIRS. Box, Harold C. (Roswell Park Memorial Inst., Buffalo). J. Phys. Chem.; 75: No. 22, 3426-31(28 Oct 1971).

From second symposium on electron spin resonance spectroscopy; Athens, Georgia (7 Dec 1970).

ESR and ENDOR spectroscopy were used to study radical pair formation in several organic systems, namely (1) formation of pairs of phenyl radicals by elimination of two molecules of CO_2 from dibenzoyl peroxide in mixed crystals (solid solutions) subjected to ultraviolet irradiation at 4.2°K; (2) formation of pair of benzoyloxy radicals by dissociation of dibenzoyl peroxide in mixed crystals x-irradiated at 4.2°K; (3) formation of radical pairs by dehydrogenation of adjacent potassium hydrogen malonate molecules in single crystals x-irradiated at 4.2°K. Of the three processes for forming radical pairs, elimination, dissociation, and dehydrogenation, only the latter appears to have general significance as a radiation damage process. The mechanism involved in the dehydrogenation of adjacent molecules is discussed in some detail. (auth)

11694 EXISTENCE IN IRRADIATED PROTEINS OF LATENT UNRECORDED CENTRES RESPONSIBLE FOR THE FORMATION OF PEROXIDE AND CYSTINE EPR SIGNALS. Aripova, D. F.; Eidus, L. Kh. (Inst. of Biological Physics, Pushchino, USSR). Biophysics (USSR) (Engl. Transl.); 16: No. 1, 150-7(1971).

Translated from Biofizika; 16: No. 1, 146-51(1971).

The existence was established of reversible transition of paramagnetic centres appearing in protein molecules on irradiation in a form not recorded by the EPR method. It was shown that under the influence of oxygen peroxide radicals form through the unrecorded damage centres. Evidence is presented showing that the neoformation of a cystine signal on heating sulphur-containing proteins irradiated at low temperature comes about through the same unrecorded centres from which the peroxide radicals form. It is shown that the transition of the paramagnetic centres to the unrecorded form is achieved by means of water, the preliminary action of which is a necessary condition for the further neoformation of peroxide and other radicals. Irradiation was with ultraviolet or γ rays. (auth)

11695 RADIATION EFFECTS ON WELDABILITY AND ADHESIVENESS OF POLYETHYLENE. Kimura, Hiroshi; Imachi, Masaki; Tsubokawa, Masakazu (Fukui Univ., Japan). Yosetsu Gakkaishi; 40: No. 9, 861-7(Sep 1971). (In Japanese).

The effects of ^{60}Co γ radiation on the fundamental characteristics, weldability, and adhesiveness of polyethylene were investigated. High-pressure polyethylene films (0.07 mm in thickness) were used in this experiment and exposed to various radiation doses up to 5×10^7 r under various ambient conditions. Measurements of the degree of crystallization, resolution rate in xylene, wettability, etc., were made. These materials were welded with a heated tool or bonded by various adhesives and then experiments on bonding strength were performed. Decay of crystal and change of degree of crystallization about irradiated polyethylene were not recognized within the limits of this experiment. It was concluded that the increase of crosslinkings due to irradiation makes weldability lower and carbonyl groups whose existence was confirmed by infrared spectra analysis improve adhesiveness. (auth) (Japan)

11696 SURFACE MODIFICATION VIA RADIATION-CHEMICAL TREATMENTS. Nasr, Hussein I. (National Research Centre, Cairo). Text. Res. J.; 41: No. 10, 859(Oct 1971).

Polyamide and polyester films and fabrics were washed with demineralized water and electronic grade acetone water, dried, weighed, treated with hexahydro-1,3,5-triacryloyl-S-triazine solutions of different concentrations, and γ irradiated. This type of radiation-chemical treatment improved significantly the wettability of films and fabrics of both nylon 6 and polyester. The treatment also proved to be of great value as a stain-release finish. (M.C.G.)

11697 ELECTRON SPIN RESONANCE DETECTION OF Sn^{3+} AND Pb^{3+} COMPLEXES IN γ-IRRADIATED STANNOUS, PLUMBOUS, and PLUMBIC SALTS. Booth, R. J.; Starkie, H. C.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Phys. Chem.; 76: No. 1, 141-2(6 Jan 1972).

Exposure of tin and lead salts or their aqueous solutions to ^{60}Co γ rays at 77°K gave centers whose ESR spectra were characterized by features in the g = 2 region (~3200 G) together with features in the 5000 G region assignable to the high-field hyperfine components of the doublets from ^{117}Sn, ^{119}Sn, and ^{207}Ob. These are assigned to Sn^{3+} and Pb^{3+} centers having A_{iso} in the region 8550 G(Sn^{3+}) and 12000 G (Pb^{3+}). (auth)

11698 ACCUMULATION OF H_2O_2 IN IRRADIATED AQUEOUS KI SOLUTIONS. Botar, L.; Kroo, E.; Zsarnay, M. (Magyar Tudomanyos Akademia Kozponti Kemiai Kutato Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 305-9(Jul-Aug 1971). (In Hungarian).

The process of accumulation of H_2O_2 in consequence of irradiation of air-saturated and deaerated aqueous KI solutions was followed by kinetic methods. (auth)

11699 IONIC PROCESSES IN 3-METHYLHEXANE INITIATED BY GAMMA IRRADIATION. Balog, J.; Toth, L.; Pinter, K. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 346-8(Jul-Aug 1971). (In Hungarian).

A study on the recombination processes of free electrons and ions, evolving during γ irradiation of 3-methylhexane, was made by conductivity measurements. The value of the recombination constant in the temperature range of 91 to 293°K was determined. (auth)

11700 JOINT EFFECT OF VARIOUS TYPES OF RADIATION ON THE ELECTRICAL CONDUCTIVITY OF ORGANIC LIQUIDS. Trofimova, T. N.; Kopylov, Yu. A.; Svergunenko, L. A.; Koval, V. M. (Dnepropetrovsk Agricultural Inst., USSR. Dnepropetrovsk Medical Inst., USSR). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 5, 650-2(May 1971).

Translated from Zh. Fiz. Khim.; 45: No. 5, 1160-3(May 1971).

The individual and combined effects of three types of radiation (x rays, ultraviolet light, and visible light) on the electric conductivity of organic liquids were studied. The long-wavelength radiation initiates recombination and therefore frequently stops the increase in conductivity arising under the influence of short-wavelength radiation. The effect of the long-wavelength radiation reduces the irreversible component of the conductivity generated by the short-wavelength radiation. (auth)

11701 INVESTIGATION OF THE FAT CHARACTERISTIC FACTOR AND FATTY ACID COMPOSITION OF PALM OIL AFTER GAMMA IRRADIATION. Bancher, E.; Washuettl, J.; Riederer, P. (Technische Hochschule, Vienna). Alimenta (Zurich); 10: No. 2, 75-7(Mar-Apr 1971). (In German).

In palm oil, irradiated with γ doses of from 1 to 11 Mrad, the characteristic factors and fatty acid composition showed practically no radiation effect. With increasing dose, however, a continuous enhancement occurred in the characteristic indices for iodine, free acids, benzidine, and refraction, while a continuous diminution was displayed by the indices for saponification, peroxide, and esters. (tr-auth)

11702 RADIATION STABILITY OF AVKh-8P AND AVI-8P QUINOLINE AND ISOQUINOLINE ANION-EXCHANGE RESINS. Kiseleva, E. D.; Khasanova, V. M.; Chmutov, K. V. (Inst. of Physical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 5, 667-9(May 1971).

Translated from Zh. Fiz. Khim.; 45: No. 5, 1192-5(May 1971).

The effects of ^{60}Co γ radiation on the quinoline and isoquinoline anion-exchange resins AVKh-8P and AVI-8P irradiated in a vacuum, in air, in water, and in 7N nitric acid were investigated. All the changes in the physicochemical structure of the irradiated and nonirradiated anion exchangers occur only as a result of the indirect effects of radiation associated with the interaction of the resin with the water and nitric acid radiolysis products. (auth)

11703 INFRARED SPECTROSCOPIC STUDY OF THE CHANGES IN THE STRUCTURE OF VP-1A ANION-EXCHANGE RESIN ON IRRADIATION. Kiseleva, E. D.; Khasanova, V. M.; Chmutov, K. V. (Inst. of Physical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 5, 669-71(May 1971).

Translated from Zh. Fiz. Khim.; 45: No. 5, 1196-9(May 1971).

The radiation stability of microporous and macroporous VP-1A anion exchange resins irradiated in a vacuum, in air, in water, and in 7 N nitric acid with a dose of 0.7×10^{23} to 1.5×10^{23} eV g^{-1} was investigated. The ion-exchange properties of the sorbents were studied and the changes in their structure examined by infrared spectroscopy. (auth)

11704 INFRARED SPECTROSCOPIC STUDY OF THE CHANGES IN THE STRUCTURE OF AVKh-8P AND AVI-8P ANION-EXCHANGE RESINS UNDER THE INFLUENCE OF IONISING RADIATION. Khasanova, V. M.; Kiseleva, E. D.; Chmutov, K. V. (Inst. of Physical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 5, 725-6(May 1971).

Translated from Zh. Fiz. Khim.; 45: No. 5, 1277-9(May 1971).

The changes in the structure of quinoline (AVKh-8P) and isoquinoline (AVI-SP) anion-exchange resins under the influence of ^{60}Co ionizing γ radiation were investigated by infrared spectroscopy. (auth)

11705 IRRADIATED SINGLE CRYSTAL CLATHRATE OF DIANIN'S COMPOUND AND 1,2-DIBROMO-1,1-DIFLUOROETHANE: ELECTRON SPIN RESONANCE OBSERVATION OF THE Br_2^- RADICAL. Kispert, Lowell D.; Pearson, Jane (Univ. of Alabama, University). Contract AT(40-1)-4062. J. Phys. Chem.; 76: No. 1, 133-4(6 Jan 1972). (ORO-4062-2).

The ESR spectrum of an x-irradiated single crystal clathrate of Dianin's compound (4-p-hydroxyphenyl-2,2,4-trimethylchroman) and 1,2-dibromo-1,1-difluoroethane was shown to consist of 7 groups of lines spread over 2600 G at g = 1.9980 when the crystals were mounted with the magnetic field parallel to the Z hexagonal crystal axis. Results using the computer program MAGNSPEC indicate that the outside high- and low-field ESR lines were due to $^{81}Br_2^-$, the middle line of the outside group was due to $^{81}Br^{79}Br^-$ and $^{79}Br^{81}Br^-$, and the inside line of the outside group was due to $^{79}Br_2^-$. (D.H.M.)

Radiation Processes

Refer also to abstract 11658.

11706 (CEA-CONF-1874) NEW INDUSTRIAL DEVELOPMENTS IN CONNECTION WITH RADIOCHEMICAL TECHNOLOGY. Laizier, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 10p. (In French). (CONF-710444-3). Dep. NTIS (U. S. Sales Only).

From International conference on chemical sciences; Paris, France (20 Apr 1971).

The sectors in industry in which new processes and products involving radiochemical technology are likely to evolve are reviewed. The fields are: polymers, paints, varnishes, wood, reconstructed and substituted materials, textiles, and other materials. This study is based upon the known effects of radiations, and the developments in techniques for producing radiations, economics and evolution in the different sectors being envisaged. (French)

11707 RADIOTHERMOLUMINESCENCE OF GRAFT COPOLYMERS BASED ON POLYETHYLENE AND AROMATIC MONOMERS. Nikol'skii, V. G.; Krasotkina, I. A.; Tikhomirova, N. S.; Tubasova, I. A. (Inst. of Chemical Physics, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 128-31(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 149-52(Mar-Apr 1971).

An investigation was made of the radiothermoluminescence (RTL) of radiation-grafted copolymers based on polyethylene and styrene, acenaphthylene, and 2,5-methylvinylpyridine monomers, and also mixtures of polyethylene with polystyrene and polyethylene with polyacenaphthylene. Grafting of aromatic monomers increases the RTL intensity by a factor of 10 to 100 in the region of the β-maximum of polyethylene, and shifts this maximum towards higher temperatures. The applicability of the RTL method to the analysis of homogeneity of graft copolymers is considered. It is shown that a mechanical mixture of polyethylene and polystyrene is heterogeneous. (auth)

11708 POLY-α-ACETOXY-4-VINYLPYRIDINE. Furuyama, Toshiyuki; Mori, Koichi; Wakasa, Ryoichi (Asahi Chemical Industries Co. Ltd., Tokyo). J. Polym. Sci., Part A-1; 9: No. 11, 3411-13(Nov 1971).

The γ-induced polymerization of α-acetoxy-4-vinylpyridine is reported. The poly(α-acetoxy-4-vinylpyridine) was slightly paler brown in color than the polymer obtained by using azobisisobutyronitrile (AIBN) method. The polymer is soluble in methanol and chloroform, partly soluble in benzene, insoluble in diethyl ether and petroleum ether, and favorably reprecipitates with chloroform and either diethyl ether or petroleum ether. Differential scanning calorimetry showed that the onset of decomposition of the polymer was 214°C. X-ray diffraction and NMR were also used to study the polymer. (D.H.M.)

11709 GRAFT COPOLYMERIZATION OF STYRENE AND LIGNIN. I. HYDROCHLORIC ACID LIGNIN. Phillips, R. B.; Brown, W.; Stannett, V. T. (North Carolina State Univ., Raleigh). J. Appl. Polym. Sci.; 15: No. 12, 2929-40(Dec 1971).

The effects of methylation of phenolic hydroxyl groups and addition of solvent on the radiation and chemically initiated graft copolymerization of styrene and hydrochloric acid softwood lignin were studied. In the γ radioinduced experiments, methylation was found to increase the maximum per cent graft obtainable two or threefold, while methanol addition can increase the value tenfold. Chemically initiated experiments indicate that the main effect of methanol addition is to increase the accessibility of the lignin particles. A mechanism of graft copolymerization of polystyrene and lignin is proposed which requires the reaction to proceed primarily by chain transfer of a polystyrene chain radical to lignin and the subsequent reinitiation of polymerization (i.e., initiation of graft copolymerization) by the lignin radical. The grafting of lignin modifications is then dependent on the type of radical formation (phenoxy or benzylic) most favored, as well as the usual accessibility considerations. (auth)

11710 RADIATION GRAFTING OF VINYL MONOMERS ONTO WOOD PULP CELLULOSE. PART I. Oraby, W.; Hopfenberg, H. B.; Stannett, V. (North Carolina State Univ., Raleigh). J. Appl. Polym. Sci.; 15: No. 12, 2987-98(Dec 1971).

The effects of dose, dose rate, monomer type, and monomer concentration on the water transport behavior in grafted cellulose pulp and hand sheets were studied. At low dose rates, grafting rates of styrene onto wood pulp were less with hand sheets than with the pulp itself. Grafting was also found to be decreased by increasing the dose rate. Grafting mixtures of styrene and acrylonitrile gave better yields than styrene alone. Excellent grafting yields were obtained by treating the pulp or hand sheets with water before adding vinyl monomers. In this way, solvents such as dioxane could be eliminated from the grafting mixture. The hand sheets, grafted with mixtures of acrylonitrile and styrene, had good mechanical properties although less than the corresponding ungrafted sheets. Grafting decreased the moisture regain in pulp and hand sheets. Gamma irradiation of wood pulp under ambient conditions without additives reduced the water sorption considerably. (auth)

11711 PHOTOCHEMICAL AND RADIOCHEMICAL ALKYLATION OF CAFFEINE BY ALKYL AMINES. Stankunas, A.; Rosenthal, I.; Pitts, J. N. Jr. (Univ. of California, Riverside). Tetrahedron Lett.; No. 50, 4779-82(Dec 1971).

It is stated that photochemical and radiochemical reactions of purines may serve as model systems of radiation damage to DNA in living organisms, and it has been shown that reactions involving alkylation of the purine bases in nucleic acids are closely paralleled by reactions of caffeine. A study was made of substitution at the 8-position of caffeine by a series of alkylamines. Irradiation was either with ^{60}Co γ rays for 48 hours at ambient temperature or with uv light from a Hg arc. The reaction mixture was separated on a silica gel column and analysis was by thin layer chromatography; product identification was by NMR, mass spectrometry, uv spectra, and m.pt. determination. Yields were 5 to 10% of total caffeine available, and the amines used and products observed are shown in tabular form. The effects of some paramagnetic ions and diamagnetic ions were also studied. A triplet state intermediate was indicated, but not processes involving ionization or fragmentation of the amine as an initial step. Unreactivity of t-butylamine implied that the presence of a H atom on the α−C to the amino group is necessary, and a possible mechanism is suggested. (UK)

11712 SILICONE TREATMENT OF VARIOUS FABRICS BY GAMMA IRRADIATION. Shimizu, H. (Tokyo Metropolitan Isotope Research Center). Genshiryoku Kogyo; 17: No. 8, 48-53(Aug 1971). (In Japanese).

Explanation is given of the graft reaction of a silicone with various fibers, water-repellent property of silicone-grafted cloth, endurance of water-repellent characteristics, and results of several experiments made for actual use of the water-repellent cloth prepared by the treatment with a silicone. Irradiation by γ rays from ^{60}Co helps the preparation of the silicone-grafted fibers, which are water-repellent. The graft percentage increases by heating after the irradiation in the case of vinylon, but hardly increases in the case of tetoron. The tensile strength of nylon and vinylon rapdily decreases with increasing dose of the irradiation, but that of other fibers such as tetoron, silk, wool, acetate fibers, and rayon does not decrease. The amount of residual silicone decreases rapidly with the time of extraction in the case of cotton without the heat treatment after irradiation, but that of 3% grafted cotton decreases only little. Studies were also made on the change of color by irradiation. (Japan)

11713 USE OF RADIATION IN POLYMER INDUSTRY. Kagiya, Tsutomu (Kyoto Univ.). Purasuchikkusu; 22: No. 2, 1-7(Feb 1971). (In Japanese).

Power which radiation can supply as an energy source is very small. In order to use radiation for chemical reactions, it is necessary to select reactions whose effects are large and to construct the reactions so as to cause chain reaction. Polymer chemistry is suitable for the use of radiation. In this paper, the first possibility of the use of radiation in the polymer industry is studied from fundamental points of view. On the basis of this consideration, the use of radiation for (i) initiation of polymerization, (ii) modification of polymers, (iii) strengthening of polymers, and (iv) disposal of polymer wastes is discussed. Problems in the use of radiation in the polymer industry and some view on its future are described. (Japan)

11714 ULTRAVIOLET- AND RADIATION-INDUCED REACTIONS OF CAFFEINE WITH AMINES. Elad, D.; Salomon, J. (Weizmann Inst. of Science, Rehovot, Israel). Tetrahedron Lett.; No. 50, 4783-4(Dec 1971).

A study is described of the uv- and γ-induced reactions of caffeine with amines that lead to the substitution of an α-aminoalkyl or alkyl group for the H atom at the 8-position. The major products isolated from reactions with aliphatic primary amines were the appropriate 8-α-aminoalkyl- and 8-alkyl-caffeine, whereas with cyclohexylamine 8-(1′-amino-1′-cyclohexyl)-caffeine was the major product. Pyrrolidine and piperidine gave 8-(2′-pyrrolidinyl)- and 8-(2′-piperidyl)-caffeine, respectively. It was found that addition of di-t-butyl peroxide increased yields. Irradiation was with ^{60}Co γ rays for 24 hours, or with uv from a Hg vapor lamp. Products were isolated by silica gel chromatography, and product identification was by elemental analysis and NMR and mass spectra. (UK)

11715 LOW-TEMPERATURE RADIATION POLYMERIZATION OF ACROLEIN IN THE SOLID STATE. III. KINETICS OF RADIATION POLYMERIZATION AND MOBILITY OF MOLECULES IN A CRYSTALLINE MONOMER. Finkel'shtein, E. I.; Abkin, A. D. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 449-50(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

The formation of polyacrolein in the solid state at low temperatures, including that of liquid helium, points to considerable mobility of the monomer molecules in the irradiated crystal. However, the fact that polymerization stops at low conversion depth indicates that this property is possessed by only a small proportion of molecules in the sample. The increase in the initial polymerization rate with rise in temperature is apparently due to the increase in the initial concentration of polymerizable monomer molecules. The data on the structure of polyacrolein formed during radiation polymerization in the solid phase show that not only translational displacement but also rotation of monomer molecules is possible in the dislocations of the crystal being irradiated. This was confirmed by the change in the content of syndio- and isotactic sequences of monomer units with change in the polymerization temperature. On the basis of the data obtained, it may be assumed that anions are active centers of polymerization of acrolein in the solid state and that the stability of the anion centers that carry out the addition of monomer from the carbonyl radical is lower than that of the centers that carry out the addition from the vinyl radical. (M.C.G.)

11716 LOW-TEMPERATURE RADIATION POLYMERIZATION OF ACROLEIN IN THE SOLID STATE. II. POLYMER STRUCTURE. Finkel'shtein, E. I.; Abkin, A. D. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 447-8(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

In order to answer the question whether a polymer is formed directly at the irradiation temperature in the solid state or on subsequent unfreezing, the method of ir spectroscopy was used. With increases in irradiation temperature, the proportion of isotactic sequences in the polymer increases. The fact that the proportion of isotactic addition increases with irradiation temperature can be taken as the direct proof of the formation of the polymer in the process of irradiation at low temperature, since such temperature dependence of the polymer structure may be attributed to the different temperature dependences of the rate constants of the reactions of iso- and syndiotactic addition. In the given case, the iso-/syndio-ratio in the polymer does not depend on the nature of the active center. The data obtained allow the activation energies (kcal/mole) of the different types of reaction of addition for polymerization in all phase states of the solid acrolein to be evaluated. (M.C.G.)

11717 LOW-TEMPERATURE RADIATION POLYMERIZATION OF ACROLEIN IN THE SOLID STATE. I. METHOD AND EXPERIMENTAL RESULTS. Finkel'shtein, E. I.; Abkin, A. D.; Gorbatov, E. Ya. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 446-7 (Sep-Oct 1969). (In Russian).

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The acrolein used consisted of a specially purified sample, dried by means of calcium hydride. The ampoules were filled, and the monomer removed after irradiation, under vacuum (10^{-3} to 10^{-4} torr). Before polymerization in the solid state, the monomer was rapidly frozen in liquid nitrogen. The irradiation was carried out using γ rays from ^{60}Co. The irradiated ampoules were heated to room temperature for 50 sec, and the monomer was separated under vacuum. The yield of polymer was determined gravimetrically. By dissolving the irradiated solid monomer (at −120°) it was shown that the contribution of the polymer formed as a result of post-polymerization during the thawing-out process could be neglected. Radiation polymerization of liquid acrolein was carried out at temperatures of −50, −78, and −90°, using 1000 rad/sec. For small degrees of conversion the reaction proceeded at constant velocity. The activation energy amounted to 1.5 kcal/mole. Polymerization of acrolein in the solid phase right up to the melting point took place only at a low rate. The rates of polymerization of rapidly frozen samples, and that of samples heated before irradiation, were identical. Samples prepared, however, by cooling down in the cryostat underwent polymerization appreciably more rapidly. The infrared spectra of polymers obtained at various temperatures show that the nature of the infrared curves, corresponding to the structure of the polyacrolein, is determined by the temperature at which the monomer undergoes irradiation. (M.C.G.)

11718 RADIOCHEMICAL PARTIAL OXIDATION OF CYCLOHEXANE IN THE LIQUID PHASE. Guetlbauer, F. (Reaktorzentrum, Seibersdorf, Austria); Hardung-Hardung, H.; Hofmann, Hd.; Corsepius, H.; Proksch, E. Chem.-Ing.-Tech.; 43: No. 17, 991-2(Sep 1971). (In German).

Experimental studies were made on the radiochemical partial oxidation of cyclohexane into cyclohexanol and cyclohexanone. Solutions of cyclohexane were enriched with oxygen and were exposed to ^{60}Co radiation at about 600 krad/hour. Within the temperature range from 125 to 160°C, the reaction velocity was strongly accelerated by radiation in comparison to the purely thermal reaction. Thermal reactions showed a definite induction time, whereas the radiochemical reaction showed no time lapse. Reaction yields could be improved by directing the radiation beam toward the oxygen-rich phases. With cobalt naphthenate as catalyst both thermal and radiochemical reaction velocities were strongly accelerated. (H.B.G.)

11719 RADIOLYTIC REACTION BETWEEN GRAPHITE AND CARBON DIOXIDE. IV. THE INFLUENCE OF CARBON MONOXIDE. Dominey, D. A.; Morley, H. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon; 9: No. 6, 725-32(Dec 1971).

The magnitude of the effect of CO on the radiation-induced reaction between CO_2 and graphite depends critically on the geometrical arrangement of the system, the temperature, and the gas pressure. When most of the irradiated gas is in the pores of the graphite the maximum effect occurs below a CO concentration of 0.5%. The absolute G(−C) in the complete absence of CO is uncertain because of the difficulty of extrapolation to such a condition. A simple mechanism is proposed which satisfactorily explains existing results and an equation is derived which describes quantitatively the effect of CO under certain experimental conditions. (auth)

11720 RADIATION CHEMICAL OXIDATION OF TRICHLOROETHYLENE. Poluektov, V. A.; Mekhryushev, Yu. Ya.; Lyapina, S. A. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 6, 524(Nov-Dec 1969). (In Russian).

Full copy of this paper is held by DTIE.

The liquid-phase oxidation of trichloroethylene initiated by the γ radiation from ^{60}Co for dose strengths of 25 to 230 rad/sec was studied in a glass reaction vessel at temperatures of 20 to 80°C. The main oxidation products are trichloroethylene oxide and dichloroacetic chloranhydride; phosgene is formed in amounts making up several percent of the weight of the trichloroethylene. (auth)

11721 MECHANISM OF THE SENSIBILIZATION OF THE RADIATION CHEMICAL OXIDATION OF BENZENE IN AQUEOUS SOLUTIONS BY MEANS OF ZINC OXIDE. Lazorenko-Manevich, R. M.; Egunov, A. V.; Stoyanovskaya, T. N.; Gurina, T. V. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 6, 523(Nov-Dec 1969). (In Russian).

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To clarify the mechanism of the sensibilizing effect of zinc oxide on the formation of phenol during γ radiolysis of zinc oxide suspensions in water–benzene mixtures, the influences of the dosage (70 to 270 rad/sec) and the electronic fraction ϵ (0 to 0.57) on the radiation yield G were investigated. G was altered by varying the potential jump between zinc oxide and the solution. The admixture of zinc oxide noticeably increases G (calculated from the energy absorbed by the entire mixture) and the increase of G is proportional to ϵ. The dependence of G on the potential, φ, of zinc oxide suggests that at least one step in the overall process of benzene oxidation is of an electrochemical nature. (auth)

11722 EFFECT OF THE IRRADIATION ENERGY ON THE ENERGY YIELD OF REACTION PRODUCTS IN THE ADDITION REACTION OF CARBON TETRACHLORIDE TO HEPTENE-1. Novozhilov, E. A.; Beer, A. A.; Zagorets, P. A. (State Scientific-Research and Design Inst. for the Nitrogen Industry and Synthetic Organic Products, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 6, 527(Nov-Dec 1969). (In Russian).

Full copy of this paper is held by DTIE.

The effect of the energy of the initiating radiation on the yield of products in the addition reaction of CCl_4 to heptene-1 was investigated for initiation by uv light, x ray ($\bar{E} \cong 50$ keV), and ^{60}Co γ irradiation. The resulting products were analyzed by gas–liquid chromatographic methods. Besides formation of the adduct (tetrachlorooctane) the formation of small quantities (≃10%) of trichlorooctane and chloroheptane in equimolar ratio was observed. It was shown that the energy yield of tetrachlorooctane by the photochemical process is greater than the energy yield of the processes initiated by x-ray or γ-irradiation. The yields were 170, 70, and 50 molecules/100 eV respectively. The reaction velocity for the photochemical and for radiation chemical additions were proportional to the first power of the dose intensities. (auth)

11723 KINETICS OF PHOSPHORUS TRICHLORIDE ADDITION TO CYCLOHEXENE UNDER THE ACTION OF γ-RADIATION. Babkina, E. I.; Vereschinskii, I. V. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 450-1(Sep-Oct 1969). (In Russian).

In order to define the optimal conditions for radiation-chemical synthesis of chloroalkyldichlorophosphines and to study the mechanism of addition, the yield of the 1 : 1 addition product (chlorocyclohexyldichlorophosphine, CCHDCP) was investigated as a function of the three basic parameters: temperature (33 to 100°C), dose intensity (7.5×10^{13} to 3.4×10^{15} eV/cm^3 · sec), and ratio of initial components (PCl_3 content of reaction mixture 90 to 10 vol. %). The effect of temperature on the yield of the desired CCHDCP product (mole % on initial cyclohexene) is shown. It was demonstrated that linear dependence of CCHDCP yield on the absorbed dose is observed only for low degrees of conversion (10 to 15 mole % on initial cyclohexene). The temperature dependence of the radiation yield takes the form of an S-shaped curve. When plotted in Arrhenius coordinates, this allows the effective energy of activation to be determined as 6 kcal/mole. The same value for the activation energy is obtained from the temperature dependence on the transformation coefficient κ in Arrhenius coordinates. From the plot of the rate of accumulation of CCHDCP against dose intensity in logarithmic coordinates, it was found that the reaction rate is proportional to the square root of the dose intensity, indicating quadratic chain termination. The variation of reaction rate with mole fraction of PCl_3 or cyclohexene is linear when plotted in logarithmic coordinates. In elucidating the mechanism of the radical-chain addition of PCl_3 to cyclohexene, it is necessary to take into account the possible formation of donor-acceptor complexes such as $[PCl_3\text{–olefin}]^*$ and $[C_6H_{10} \cdot PCl_2 \cdot PCl_3]^*$. The effect of a light flash in PCl_3 vapor is to produce an absorption band

having a half life longer than one second. A life of this duration for an excited state of PCl_3 obviously facilitates the formation of complexes. (auth)

11724 ROLE OF SOME INHIBITORS IN THE RADIATION SULFOCHLORINATION OF PARAFFINIC HYDROCARBONS. Dzhagatspanyan, R. V.; Lyaskin, Yu. G. This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 465(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

Experiments were carried out on the radiation sulfochlorination of n-decane with a mixture of SO_2 and Cl_2 in the presence of sulfuryl chloride. Although a considerable fall in selectivity was observed at fairly high concentrations of SO_2Cl_2, nevertheless the hypothesis put forward on the possibility of the occurrence of the reaction ($SO_2Cl_2 + R \rightarrow SO_2Cl + RCl$) is basically true. To explain the effect of the acceleration of the process on changing the work of the RS-2.5 sulfochlorinator from batch conditions to continuous conditions, the role of oxygen in the radiation sulfochlorination of the paraffins was studied. Under certain conditions expressed by the magnitude of the ratio of the dose rate to the concentration of oxygen in the gas phase, namely at $P/[O_2]_g > 30 \pm 8$ rad/sec · mole %, some, although slight, increase in selectivity was observed. However, the essence of the phenomenon consists not in the selective inhibition of the chlorination but in a general sensitization of the chain process through the development of the well-known chain of the reactions of the sulfooxidation of the paraffins. As a result of the degenerate branching of the radical chain and the acceleration of the kinetic stage of the heterophase process connected with it, the system passes into the deep diffusion region which leads to an increase in selectivity. The suggested explanation is confirmed by the results of a determination of the free sulfonic acids in the presence of oxygen and in its absence. (auth)

11725 RADIATION CHLORINATION OF PARAFFINS. VI. CHLORINATION OF n-TETRADECANE UNDER STATIC CONDITIONS. Dzhagatspanyan, R. V.; Kosorotov, V. I. This paper was summarized in Khim. Vys. Energ.; 3: No. 6, 531-2(Nov-Dec 1969). (In Russian).

Full copy of this paper is held by DTIE.

The kinetics of chlorine consumption in the solution due to the reaction at a dose rate of 0.3 R/sec and at varying temperatures (10–35°C) were studied. The initial chlorine concentration varied from 0.4 to ~0.5 mole/liter and from 0.8 to ~0.4 mole/liter. It was shown that the rate of radiation chlorination is independent of the dissolved chlorine concentration in the range 0.05 to 0.8 mole/liter. In the range 10 to 35°C the activation energy is 7.2 ± 0.5 kcal/mole. The reaction rate at 20°C and various dose rates was determined. In the given case the reaction rate is proportional to the radiation dose rate, which confirms the presence of linear termination of the kinetic radical chains by the inhibitor. From the experimental data, kinetic analysis of the scheme of the chain reaction initiated by decomposition of the hydrocarbon into radicals (the electron proportion of chlorine in the solution is less than 5%), with linear termination by the inhibitor, it can be inferred that the limiting stage of chain growth is the reaction $RH + Cl \rightarrow \dot{R} + HCl$. A study was made of the kinetics of the reaction of chlorine with chlorinated tetradecane containing ~4 atoms of chlorine per molecule. The reaction rate again remained constant in the chlorine concentration range 0.05 to 0.8 moles/liter. (auth)

11726 RADIATION CHLORINATION OF PARAFFINS. VII. THE HOMOGENEOUS CHLORINATION OF n-OCTANE IN A REACTOR WITH A PRELIMINARY ABSORBER. Dzhagatspanyan, R. V.; Kosorotov, V. I.; Luzyanin, B. P.; Il'icheva, I. A. This paper was summarized in Khim. Vys. Energ.; 3: No. 6, 532 (Nov-Dec 1969). (In Russian).

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A study was made of the radioinduced chlorination of n-octane in a homogeneous reactor. The hydrocarbon was submitted to preliminary saturation with chlorine in an absorber immersed within the irradiation chamber; the solution was subsequently passed into the reactor. The chlorinated octane was analyzed with respect to the content of combined and dissolved chlorine, and, in addition, the quantities of octane, and of its mono- and polychlorinated derivatives were determined on the chromatograph LKhM-7A. It was observed that, in the preliminary absorber, where a temperature between 10 and 15°C was maintained, reaction was entirely absent. In both reactors a temperature of 25°C was maintained, and the maintenance time for the liquid was 25 min. The power of the radiation dose amounted to 2 rad/sec. The data show that the extent of selectivity (ratio of monochlorides) in the homogeneous reactor is appreciably higher than in the bubbling reactor. (auth)

11727 RADIATION CHLORINATION OF PARAFFINS. V. CHLORINATION OF n-OCTANE IN THE LIQUID PHASE. Dzhagatspanyan, R. V.; Kosorotov, V. I.; Luzyanin, B. P.; Sobolev, I. A.; Il'icheva, I. A. This paper was summarized in Khim. Vys. Energ.; 3: No. 6, 531(Nov-Dec 1969). (In Russian).

Full copy of this paper is held by DTIE.

Chlorination of octane to different degrees of conversion (0 to 0.8 atoms of Cl/C_8 molecule) revealed that the ratio of the amounts of polychlorides to monochlorides, q, varies with the reaction procedure. This ratio increases monotonically in the series homogeneous chlorination, bubbling chlorination with a stirrer, chlorination without a stirrer, and chlorination on a smooth surface. The experimental temperature was 25°C. The change in the ratio of the product yields of the final chlorination reaction in this series is due to the effect of mass transfer. With chlorination under diffusion conditions, when the reaction takes place mainly near the interface, the probability of chlorination of the same molecule is high. This increases the yield of polychlorides. The faster the rate of exchange of the hydrocarbon in the diffusion film with the bulk of the liquid, the smaller is the effect of mass transfer. With homogeneous chlorination the ratio of the rate constants of successive replacement of hydrogen atoms by chlorine k_1/k_2 was found to be 1.15. Bubbling radiation from ^{60}Co source (dose rate 1.5–200 R/sec, chlorine flow rate 50 to 700 cm^3/min with an octane volume of 30 cm^3) and thermal chlorination at 100°C gave identical results; the yield of the reaction products may be calculated from equations for monomolecular transformations with $k_1/k_2 = 0.82$. The coefficient of utilization of the hydrocarbon feedstock in the manufacture of hydrocarbon monochlorides may be calculated from the given distribution. This value has an optimum with respect to the degree of chlorination. (auth)

11728 CALORIMETRIC STUDY OF SOLID-STATE RADIATION POLYMERIZATION. II. POSTPOLYMERIZATION OF SOLID ACRYLONITRILE. Kaplan, A. M.; Kiryukhin, D. P.; Barkalov, I. M.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 461-3(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

A diathermic calorimeter was used to investigate the radiation postpolymerization of acrylonitrile (AN). Using identical calorimeter-signal amplifications and working in the temperature ranges 110 to 155°K and 155 to 180°K, curves were obtained. The heats of polymerization of AN obtained in the previous investigation were used to determine the polymer yield during heating of the irradiated AN (II) from the calorimetric data. After recording the heating thermograms for the irradiated AN (II) specimens, the polymer yield was determined gravimetrically. Comparison of the yields found by the gravimetric and calorimetric methods showed that formation of only part of the polymer produced after melting of the AN (II) could be traced calorimetrically during heating (the gravimetric method gave a figure of 7.6 ± 0.5%, as against 5.4 ± 0.5% for the calorimetric data at a dose of 5 Mrad). The start of heat evolution as a result of postpolymerization of the AN (II) was not associated with any particular temperature and was recorded earlier as the sensitivity of the calorimeter and the preliminary irradiation dose were increased, active-center accumulation being related to the latter factor. In addition to postpolymerization, an endothermic phase transition was always observed during heating of specimens irradiated in doses of 0.5 to 20 Mrad. The existence of an ionic mechanism for initiation of the solid-state postpolymerization of AN is indicated by the fact that a limiting concentration of active centers, which govern postpolymerization, was reached at a small dose (about 5 Mrad) and that there was an abrupt decrease in the polymer yield (from 7.6 ± 0.5% to 1.0 ± 0.6% at a dose of 5 Mrad) after thawing of AN specimens subjected to irradiation at the temperature of liquid nitrogen and bleaching at 77°K with a DRSh-500 bulb in comparison with unbleached specimens. (auth)

11729 RADIATION POLYMERISATION. Rao, K. N.; Rao, M. H.; Kumar, Vijay (Bhabha Atomic Research Centre, Trombay, India). pp 69-82 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC-489; CONF-700214.

The identification of the primary initiating species in radiation polymerization and measurement of its concentration are discussed. Radical processes in polymerization of vinyl benzoate and ionic processes for trioxane were investigated. (M.C.G.)

11730 RADIATION-INITIATED REACTION OF STYRENE WITH BLENDS OF COTTON AND RAYON. Harris, James A.;

Arthur, Jett C. Jr. (Dept. of Agriculture, New Orleans). J. Polym. Sci., Part B; 9: No. 12, 915-21(Dec 1971).

Data are presented that show that selective graft copolymerization of styrene with preirradiated cotton and rayon, alone and in fabric blends, can be accomplished. The accessibilities of the free radical sites in the two types of preirradiated cellulose, cellulose I for cotton and cellulose II for rayon, to styrene are apparently dependent on the solvent used. (D.H.M.)

11731 RADIATION HARDENING OF OLIGOMERIC ESTERO-ACRYLATES. Amelina, M. A.; Makashov, G. F.; Khoroshilova, I. P.; Bocharnikov, V. K.; Bublik, V. A. Plast. Massy; No. 4, 5-7(Apr 1971). (In Russian).

Studies were conducted on the effect of chemical structure of polyesters, particularly oligomeric acrylate esters, on the rate of their radiation polymerization, physical and mechanical properties of radiation hardened products, and the magnitude of radiation dose that is necessary to produce materials with optimum physical and mechanical indices. Commercial oligomeric acrylate esters were investigated: MGF-7, MGF-8, MGF-9, and TMGF-11. A ^{60}Co gamma radiation source was used at room temperature. The dose rate was 180 rad/sec. Thermochemical polymerization was conducted in parallel to radiation hardening for comparison. It was found that radiation polymerization of oligomeric acrylate esters produces higher quality products than those obtained by ordinary thermochemical polymerization. Since the radiation doses which are needed in order to obtain radiation hardening of polymers are low the use of this method in certain cases is expedient. (JPRS)

11732 RADIATION-INDUCED GRAFTING OF STYRENE TO POLYETHYLENE AND HEXATRIACONTANE. Kamel, Ihab Labib. College Park, Md.; Univ. of Maryland (1971). 105p. University Microfilms Order No. 71-24,279.

Thesis.

The radioinduced graft polymerization of styrene to low-density polyethylene film was studied at room temperature as a function of the sorbed styrene and compared with the grafting to hexatriacontane (HTC). Two methods were used for varying the concentration of styrene in the polyethylene: exposing the film to monomer vapor for various time intervals and immersing the film in various solutions of styrene and methanol. In both methods, similar grafting rates were obtained as a function of monomer concentration; vapor phase grafting gave lower yield values due to the effect of diffusion. Methanol diffusion into polyethylene was found to be negligible and did not influence the kinetics of the grafting reaction. The grafting rate of styrene to polyethylene film exhibited a maximum at 4% styrene concentration when grafting in the vapor phase and at 6.2% when grafting with a methanol solution. The results are explained in terms of the concentration of sorbed monomer and its effect on the viscosity of the amorphous region of polyethylene when partially swollen by the monomer. The proposed model conflicts with models of earlier publications which explain the accelerating effect of methanol on the grafting rate in terms of radiation protection effects and chain conformation. Supporting evidence for the mechanism is presented by kinetic data and molecular weight measurements when grafting styrene vapor to HTC crystals over a dose rate range of 3×10^3 to 3×10^5 rad/hr. Grafting styrene liquid to HTC crystals was performed with different HTC–styrene suspensions and compared with calculations based on several models. The results fit a model which postulates 100% efficiency of radical migration to the surface of the crystals and conversion to graft chains. An important practical consequence is the demonstration of how monomer vapor and dilute monomer solutions can yield much higher grafting rates than pure monomer liquid, and how the gain in grafting yield can be accompanied by a better product and reduced monomer losses. (Diss. Abstr. Int., B)

11733 RADIATION CHEMICAL OXIDATION OF ETHYLBENZENE IN THE PRESENCE OF ETHYLBENZENE HYDROPEROXIDE. Kroo, E.; Danoczy, R.; Gal, Dezso (Magyar Tudomanyos Akademia Kozponti Kemiai Kutato Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 349-50(Jul-Aug 1971). (In Hungarian).

Ethylbenzene was irradiated in the temperature range 20 to 90°C. Over 50°C the process takes place as a high-speed chain reaction, independent of temperature. (auth)

11734 RADIATION CHEMICAL ALKYLATION OF ETHYLENE. Foldiak, G.; Stenger, V.; Jakab, A. (Magyar Tudomanyos Akademia Izotop Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 342-5(Jul-Aug 1971). (In Hungarian).

When methane and ethylene are irradiated above 180°C, dimerization and alkylation reactions take place with high G value. (auth)

11735 RADIATION POLYMERIZATION FROM THE GASEOUS PHASE ONTO MINERAL SURFACES. Golubev, V. N.; Komarova, L. I. (Inst. of Elemental Organic Compounds, Moscow). Dokl. Akad. Akad. Nauk. SSSR; 198: No. 5, 1085-8(11 Jun 1971). (In Russian).

Methyl methacrylate and styrene monomers in the gaseous phase were induced to copolymerize in the presence of x radiation on MgO surfaces. By dissolving away the MgO supports in HCl, the weight of the polymer film was obtained. The composition of the polymer and the rate of copolymerization were studied as a function of the initial composition of the reacting monomers. However, it was impossible to exclude the possibility of obtaining merely a mixture of poly(methyl methacrylate) and polystyrene instead of a true copolymer. (K.S.W.)

11736 PROPERTIES OF THE TRIACETATE OF COPOLYMERS OF CELLULOSE WITH SOME VINYL MONOMERS. Azizov, U.; Afaki, N. I. Uzb. Khim. Zh.; No. 3, 51-4(1971). (In Russian).

The kinetics of acetylation of branched copolymers of cellulose were investigated with the following materials: poly(methyl acrylate), poly(methyl methacrylate), polystyrene, and poly(vinyltoluene), produced by the radiation method. Cotton cellulose and solutions of the monomers were given a 1-MRad dose of ^{60}Co radiation in order to synthesize the copolymers. Acetylation rates were in all cases higher than with the original cellulose alone. The deformation of the copolymers and the original cellulose was measured as a function of temperature. Other physical properties are also discussed. (K.S.W.)

11737 KINETICS OF CHAIN TERMINATION IN RADIATION GRAFT COPOLYMERIZATION. Czvikovszky, T. (Muanyagipari Kutato Intezet, Budapest). Izotoptechnika; 14: No. 7-8, 366-71(Jul-Aug 1971). (In Hungarian).

In the simultaneous irradiation of polyethylene and styrene the kinetics of chain termination was studied by determining some of its characteristic parameters. (auth)

11738 RADIATION POLYMERIZATION OF CRYSTALLINE N-VINYLCARBAZOLE. Azori, M.; Tudos, F.; Mohos, B. (Magyar Tudomanyos Akademia Kozponti Kemiai Kutato Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 364-5(Jul-Aug 1971). (In Hungarian).

The velocity of radiation-initiated postpolymerization of crystalline N-vinylcarbazole and the attainable limiting conversion were investigated as a function of temperature and dose. ESR spectra were taken to determine the mechanisms of processes. (auth)

11739 CALORIMETRIC INVESTIGATION OF POSTPOLYMERIZATION OF ACRYLONITRILE–CARBAMIDE CHANNEL COMPLEX. Polgar, S. (Muanyagipari Kutato Intezet, Budapest); Kaplan, A. M.; Kiss, L.; Barkalov, I. M. Izotoptechnika; 14: No. 7-8, 361-3(Jul-Aug 1971). (In Hungarian).

The kinetics of postpolymerization of acrylonitrile–carbamide channel complex after irradiation was investigated by means of a thermoconduction calorimeter. Some characteristic parameters of the process were determined. (auth)

11740 RADIATION COPOLYMERIZATION OF ACROLEIN AND ACRYLONITRILE IN CARBAMIDE CHANNEL COMPLEX. Kiss, L.; Polgar, S. (Muanyagipari Kutato Intezet, Budapest). Izotoptechnika; 14: No. 7-8, 358-60(Jul-Aug 1971). (In Hungarian).

The composition of copolymer, produced by polymerizing the acrolein–acrylonitrile monomer pair in carbamide channel complex, proved to be independent of conversion and was identical with the composition of the initial monomer mixture. (auth)

11741 POLYMERIZATION REACTION INITIATED BY RADIATION AND THE PROBLEM OF THERMAL EXPLOSION. Dobo, J. (Muanyagipari Kutato Intezet, Budapest). Izotoptechnika; 14: No. 7-8, 351-7(Jul-Aug 1971). (In Hungarian).

According to a comparison of polymerization reactions initiated by chemical means and by radiation, respectively, the latter has the advantage from the industrial viewpoint of eliminating the possibility of thermal explosion. (auth)

11742 LARGE SCALE RADIATION-INDUCED CHEMICAL PROCESSING. Stannett, V. T.; Stahel, E. P. (North Carolina State Univ., Raleigh). Annu. Rev. Nucl. Sci.; 21: 397-416(1971).

The large-scale processes considered are industrial processes already in progress and those presently under pilot plant study. Radiation sources include both isotopes and machines. The processing discussed includes: ethyl bromide synthesis, sulfoxidation, crosslinking of polymers, degradation of polymers, modi-

fication of textiles, curing of coatings, polymerization, and production of wood–polymer and concrete–polymer composites. (46 references). (M.C.G.)

Radiolysis

Refer also to abstracts 12182, 12233, 12567, 12726, and 13420.

11743 (AE–413) PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS OF ANILINE AND SUBSTITUTED ANILINES. Christensen, H. C. (Aktiebolaget Atomenergi, Stockholm (Sweden)). 1971. 40p. Dep. NTIS (U. S. Sales Only).

The primary reactions of hydrated electrons, hydrogen atoms, and hydroxyl radicals with aniline and the aniline cation in aqueous solutions were studied by the technique of pulse radiolysis and by determination of end products after γ radiolysis. Hydrogen atoms and hydrated electrons react with aniline with formation of the cyclohexadienyl-type radical with an absorption maximum at 355 nm and an extinction coefficient of 4100 M^{-1} cm^{-1}. A similar radical formed by reaction of hydrogen atoms with the aniline cation has its absorption maximum at 310 nm and an extinction coefficient of 3200 M^{-1} cm^{-1}. Hydrogen atoms react with the acid and neutral forms of aniline with rate constants of $(1.3 \pm 0.2) \times 10^9$ M^{-1} s^{-1} and $(2.9 \pm 0.7) \times 10^9$ M^{-1} s^{-1}, respectively. OH radicals react with aniline with a rate constant of $(1.4 \pm 0.3) \times 10^{10}$ M^{-1} s^{-1} with formation of the cyclohexadienyl radical OH/NH_2 with absorption maximum at 355 nm and the anilino radical with absorption maxima at 300 and 400 nm. The cyclohexadienyl radical decayed in a first order process with a rate constant of 1.4×10^5 s^{-1} by elimination of NH_3 whereas the anilino radical disappeared in a second order reaction with formation of hydrazobenzene. O^- radicals react with aniline at pH 13.3 with a rate constant of $(3.1 \pm 0.6) \times 10^9$ with formation of anilino radicals. The reaction of OH radicals with the aniline cation produced the anilino radical cation with a rate constant of $(4.8 \pm 0.8) \times 10^9$. The absorption maximum was placed at 415 nm. The cyclohexadienyl-type radical with absorption maximum at 350 nm was also found in aqueous solutions of 2-amino-1,3-dimethylbenzene but was not formed in solutions of N,N-dimethylaniline. (auth)

11744 (INR–1312) RADIOLYSIS OF n-DODECANE–TBP–HNO_3 AND n-PARAFFINS–30 PERCENT TBP–3M HNO_3. Nowak, Zofia (Institute of Nuclear Research, Warsaw (Poland)). 1971. 17p. (In Polish). Dep. NTIS (U. S. Sales Only).

The radiolysis of n-dodecane in a two phase system as a function of the concentration of HNO_3 and TBP was investigated. The yield of nitro compounds did not increase linearly as a function of the concentration of nitric acid. The yield of carbonyl compounds reached its highest value at the concentration of about 2M of nitric acid. Hydroxamic acids were observed at nitric acid concentration <2M. The curve of the relationship between the yield of nitro compounds and the concentration of TBP in n-dodecane goes through a maximum at 15% TBP and the yield of carbonyl compounds and the extraction of uranyl nitrate increase as a function of the concentration of TBP in the systems under investigation. The n-paraffins fraction C_{10}–C_{14} separated on the molecular sieves showed radiolytic stability similar to n-dodecane. (auth)

11745 (NYO–2499-36) EFFECTS OF MERCAPTANS AND DISULFIDES ON PHOTOCHEMICAL AND HIGH ENERGY RADIATION INDUCED REACTIONS. Progress Report. Cohen, Saul G. (Brandeis Univ., Waltham, Mass. Dept. of Chemistry). 1 Nov 1971. Contract AT(30-1)-2499. 15p. Dep. NTIS.

The ^{60}Co γ radiolysis of dilute aqueous solutions of methyl acetate (MeAc) was studied. Ethylene diacetate (EDA) and methyl acetoxypropionate (MAP) were observed, accounting for about half the MeAc that disappears. The effects of sodium formate, carbon monoxide, 2-propanol, nitrous oxide, hydrogen peroxide, and sodium-2-mercaptopropionate on the yields from the radiolysis were also studied. (D.H.M.)

11746 (ORO–4179-9) RADIOLYTIC INVESTIGATIONS OF AQUEOUS MICELLAR SYSTEMS. Annual Progress Report, April 1, 1971–November 30, 1971. Fendler, Janos H. (Texas Agricultural and Mechanical Univ., College Station. Dept. of Chemistry). Contract AT(40-1)-4179. 8p. Dep. NTIS.

11747 FORMATION OF PEROXIDE RADICALS IN VITREOUS HYDROCARBONS DURING γ-IRRADIATION IN THE PRESENCE OF MOLECULAR OXYGEN. Zimina, G. M.; Karasev, A. L.; Bakh, N. A. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 156-7(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 176-7(Mar-Apr 1971).

Spectrophotometry and EPR were used to study the formation of peroxide radicals after γ irradiation at 77°K of the following vitreous hydrocarbons: 2,3,5-trimethylhexane, isopentane, 3-methyl-1-pentene, 3-methyl-2-pentene, and 1-heptene. In the absence of O_2, optical absorption in the uv region $\lambda > 240$ nm was not observed, and the EPR spectra indicate that only alkyl radicals were formed. The presence of 10^{-2} M O_2 produced absorption with a maximum at ~260 nm, and the characteristic EPR singlet of peroxide radicals. 1-heptene required a standing period of 24 hr after irradiation before the peroxide radicals could be observed. Extinction coefficients of the peroxide radicals were calculated and compared with those of other substances studied previously. (D.L.C.)

11748 RADICALS FORMED DURING RADIOLYSIS OF SODIUM DECYLSULFONATE AND ITS AQUEOUS SOLUTIONS. Brusentseva, S. A.; Grishina, A. D.; Shubin, V. N. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 2, 158-9(Mar-Apr 1971).

Translated from Khim. Vys. Energ.; 5: No. 2, 177-9(Mar-Apr 1971).

The EPR spectra of sodium decylsulfonate crystals and 3×10^{-2} M frozen solutions gamma-irradiated in air and vacuum were studied at 77°K. The basic spectrum is attributed to an alkyl radical with a yield of 5.0 radicals/100 eV. In warmed and refrozen air-irradiated specimens, the alkyl radical is converted to a peroxide radical, the conversion beginning at −120°C and reaching completion at −35°C. When vacuum-irradiated specimens are warmed and refrozen, new radicals (I) are formed which have the unpaired electron on the sulfur atom. Irradiation of frozen aqueous solutions produces OH radicals which are destroyed by thawing, resulting in the formation of the above radicals (I). Thus, the longest-living radicals in both the salt and solution are those with an unpaired electron on the sulfo group. (D.L.C.)

11749 SOLVATED ELECTRONS IN IRRADIATED HEXAMETHYLPHOSPHORTRIAMIDE. Mal'tsev, E. I.; Vannikov, A. V.; Bach, N. A. (Inst. of Electrochemistry, Moscow). Radiat. Eff.; 11: No. 2, 79-84(Nov 1971).

Pulse radiolysis methods with simultaneous optical and electrical registration were used in a study of transient charged species in pure hexamethylphosphortriamide (HMPA) and its solutions of alkaline metal salts. A number of transient optical absorption bands were observed, including the solvated electron (e_s) spectrum. Using the experimental technique it was possible to establish some primary reactions in the radiolysis mechanism of HMPA and to determine mobility values of charged species. In the case of salt solutions an increase of $G(e_s)$ up to the value of total ionization as a result of salt concentration increase (10^{-3} to $3 \cdot 10^{-1}$ M) was observed. The possibility of thermalized electron stabilization by cations of alkaline metals is discussed. The concentration dependence of $G(e_s)$ is described by an analytical formula if one assumes that e_s is stabilized by metal cations in the form of a complex $[M^+ \ldots e_2^-]$. The transient absorption band observed in the near ir is ascribed to this complex. The time of initial recombination is estimated. (auth)

11750 FURTHER ESR STUDIES OF γ-IRRADIATED HYDRATED SODIUM NITROPRUSSIDE. Bloom, M. B. D.; Raynor, J. B.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 23, 3843-6(1971).

Four paramagnetic centers were detected and characterized by ESR in hydrated sodium nitroprusside after exposure to γ-rays at 77°K. One, shown to be nitric oxide, only gave a detectable signal at 19°K. Two others, very closely related, were similar to the nitric oxide center except that A_{iso} was ca 17 G rather than ca 6 G. These centers are thought to be $[Fe^{II}(CN)_5NO]^{3-}$ ions with the unpaired electron in a pseudo-π-orbital, largely centered on the NO ligand. The fourth center, stable at room temperature, is a normal low-spin d^7 iron complex, previously identified as $[Fe^{I}(CN)_5NO]^{3-}$. Careful examination of the low temperature ESR spectra of this species has revealed possible shoulders indicative of interaction with a nucleus with I = 1 and having A = ca 2–3 G. By analogy with the behavior of various hexacyanides, it is tentatively suggested that the trans-cyanide has become an isocyanide. (auth)

11751 PULSE RADIOLYTIC INVESTIGATION OF THE MECHANISMS OF OXIDATION AND AUTOXIDATION OF FORMALDEHYDE IN AQUEOUS SOLUTIONS. Stockhausen, K.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem.; 75: No. 8, 833-40(Aug 1971). (In German).

The absorption spectra of both forms were measured. The acid and basic form can transfer an electron to nitrobenzene with k =

1.9×10^9 and 4.5×10^9 M^{-1} s^{-1}, respectively. The radical disproportionates to yield formic acid, the rate constant amounting to $2k = 7.2 \cdot 10^8$ M^{-1} s^{-1} and pH = 6 and $4.5 \cdot 10^8$ M^{-1} s^{-1} at pH = 12. The reaction of the hydrated electron with carbon monoxide also yields the dihydroxymethyl radical. In the presence of small amounts of oxygen, the dihydroxymethyl radical adds O_2 with $k = 7.7 \cdot 10^8$ M^{-1} s^{-1}. An electron transfer leading to O_2^- could be excluded. The peroxy radical produced is a bivalent acid. The pK is 4.8 and 10.5, respectively. The absorption spectra of the two forms were measured. The peroxy radical disappears by second order with $2k = 7 \cdot 10^7$ M^{-1} s^{-1}. The product is conducting in slightly acid and in alkaline solutions, possesses a pH dependent uv absorption, and produces formic acid plus hydrogen peroxide in a first-order process with $k \sim 12$ s^{-1}. These observations can quantitatively be explained, if it is assumed that two peroxy radicals form formic acid and hydrotetroxide. The hydrotetroxide is dissociated protolytically or in the O_4-chain depending on the pH. The pK values are 4.4, 8.2, and 11.2, respectively, if homolysis in the O_4-chain is negligible. (auth)

11752 HEATS OF IONIZATION OF HO_2 AND OH IN AQUEOUS SOLUTION. Baxendale, J. H.; Ward, M. D.; Wardman, P. (Univ. of Manchester, Eng.). Trans. Faraday Soc.; 67: No. 585, 2532-7(Sep 1971).

Acid dissociation constants of OH and HO_2 were measured over a range of temperature and give heats of ionization of 10 and 0 kcal mol^{-1} respectively. These values lead to ΔH_f^0 of $(O_2^-)_{aq}$ and $(O^-)_{aq} = -8(\pm 2)$ and $9(\pm 2)$ kcal mol^{-1} respectively. Solvation energies of O_2^- and O^- are estimated to be 94 and 113 kcal mol^{-1} and the E^0 of the couples O_2/O_2^-, O/O^-, −0.19 and 1.64 V respectively. (auth)

11753 MASS SPECTROMETRY OF GAMMA-IRRADIATED AMINO ACIDS AND PEPTIDES. Kushelevsky, A. P.; Slifkin, M. A. (Univ. of Salford, Eng.). Radiat. Eff.; 11: No. 2, 91-7 (Nov 1971).

Changes in the mass spectra of amino acids and dipeptides were observed after γ-radiolysis. The primary reaction in the dipeptides is bond cleavage. Pyrolysis reactions due to local heating appear to play no part in the radiolysis of these substances in the solid state. (auth)

11754 FREE RADICALS IN A SINGLE CRYSTAL OF GLYCYL-GLYCINE AT ROOM TEMPERATURE. Meloe, Thor B. (Univ. of Oslo). Int. J. Radiat. Biol.; 20: No. 6, 557-75(1971).

The hyperfine splitting of the doublet lines was used to identify the different stable modifications of the glycylglycine radicals induced by irradiation of single crystals. Two types of single crystals were examined. With the aid of theoretical calculations, the radical fragments $H_3CCONHCHCOO^-$ and $H_3CCONHCHCOOH$ were found as the remains of the radiation lesions at room temperature when the crystals did not contain water of crystallization. If the crystals contained water of crystallization, in addition to these, the radical types $^+H_3NCH_2CONHCHCOOH$ and possibly $^+H_3NCHCONHCH_2COO^-$ were also found. (auth)

11755 COMPUTER-CONTROLLED EPR ANALYSIS OF FREE RADICAL FORMATION IN DRY THYMINE AND DERIVATIVES AFTER ELECTRON IRRADIATION. Hartig, Gunter; Dertinger, Hermann (Kernforschungszentrum, Karlsruhe, Ger.). Int. J. Radiat. Biol.; 20: No. 6, 577-88(1971).

Radical formation and transformation in electron irradiated dry thymine, thymidine, thymidine-5′-monophosphate, and DNA were studied with 35 GHz electron paramagnetic resonance. Dry samples were irradiated at 77°K and the EPR spectra taken at 77 and 300°K under anaerobic conditions. The spectra of the cation and the anion radical of thymine were identified. It was shown that the cation easily underwent deprotonization. Conversely, the anion radical was transformed into the 5,6-dihydro-5-thymyl radical by proton capture. These processes were found to be significant for all the compounds investigated. (auth)

11756 ELECTRON MICROSCOPE STUDIES OF SOLIDS PRODUCED BY α-RADIOLYSIS OF CARBON MONOXIDE. Baird, T. (Univ. of Glasgow). Carbon; 9: No. 6, 773-81 (Dec 1971).

Solid deposits were produced by α-radiolysis of carbon monoxide gas, the irradiations being conducted wholly within a Siemens electron microscope. Iron and nickel carbonyl impurities in the carbon monoxide were shown to exert a profound influence both on the nature of the solid produced and on the deposit yields. (auth)

11757 LIQUID-PHASE γ-RADIOLYSIS OF BENZENE-NITROUS OXIDE MIXTURES. Hirokami, Shun-ichi; Shishido, Seishi; Sato, Shin (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 44: No. 6, 1511-14(Jun 1971).

The γ radiolysis of benzene–nitrous oxide liquid mixtures was studied at room temperature and at 0°C, the mixing ratios covering almost all the range from pure benzene to pure nitrous oxide. Phenol was found to be one of the main products; its G-value is about half that of nitrogen at the lower concentration of nitrous oxide. Kinetic analysis shows that the G-values of electrons from benzene are 3.2 ± 0.2. An empirical equation for expressing the G-value of nitrogen from the benzene solution of nitrous oxide proposed by Hentz and Sherman (J. Phys. Chem., 73, 2676 (1969)) was examined. The agreement was very poor at higher concentrations of nitrous oxide. Possible reasons are discussed. (auth)

11758 ESR MEASUREMENT AND IRRADIATION AT VARIABLE TEMPERATURES BELOW 77°K. Iwasaki, Machio; Nunome, Keichi; Ichikawa, Takahisa; Toriyama, Kazumi (Government Industrial Research Inst., Nagoya, Japan). Bull. Chem. Soc. Jap.; 44: No. 6, 1522-6(Jun 1971).

An apparatus for irradiation and subsequent ESR measurements at variable temperatures below 77°K was constructed by combining an ESR spectrometer, an x-ray irradiator, and a laboratory-scale low-temperature refrigerator operating at the temperature region between 77 and 4.2°K. A device for rotating the single crystal specimen was made to measure the angular dependence of the ESR spectra. The lowest specimen temperature achieved was estimated to be 6°K and the precision of the temperature control was less than ±0.5°K for a period of several hours. The apparatus makes it possible to irradiate samples and to measure ESR spectra at any temperature in the range between 77 and 6°K. Some applications for irradiation and ESR measurements at low temperature in the range between 77 and 6°K. Some applications for irradiation and ESR measurements at low temperatures are also described. An unstable radical that disappears at about 60°K was found in an irradiated single crystal of L-cystine dihydrochloride. Experimental evidence for the quantum tunnelling of the methyl group in poly(methyl methacrylate) radical was also found by the temperature dependence of the spectra observed at temperatures lower than 77°K. (auth)

11759 RADIATION DAMAGE BY SOFT β-PARTICLES. SELF-IRRADIATION OF β-TRITIATED POLYSTYRENE. Weir, N. A. (Lakehead Univ., Thunder Bay, Ont.). Radiat. Eff.; 11: No. 1, 23-7(Oct 1971).

The effects of self-irradiation of β-tritiated polystyrene under high vacuum at 25°C were studied, and simultaneous random chain scission and cross-linking were observed. Analyses of the gaseous products and the colored polymer residue showed that hydrogen was the only volatile product, while spectroscopic measurements indicated that the coloration was associated with the presence of main-chain double bonds. G-values for hydrogen formation G_{H_2}, cross-linking, G_{XL} and chain scission, G_{CS} were obtained as follows: $G_{H_2} = 0.031$; $G_{CS} = 0.044$; $G_{XL} = 0.061$. Possible mechanisms of radiation damage are discussed. (auth)

11760 RADIATION STABILITY OF PERFLUOROBENZENE AND PERFLUORODIPHENYL AT ELEVATED TEMPERATURES. Barabadze, K. V.; Makoveev, E. A.; Radaikina, L. A.; (and others). This paper was summarized in Khim. Vys. Energ.; 3: No. 6, 528(Nov-Dec 1969). (In Russian).

Full copy of this paper is held by DTIE.

The radiolysis of perfluorobenzene and perfluorodiphenyl in the liquid phase at 20 to 400°C and the gas-phase radiolysis of perfluorobenzene at 150 to 200°C were studied. Irradiation of the liquid samples was performed in nickel cuvettes with ^{60}Co γ rays. To irradiate gaseous perfluorobenzene, electrons with an energy of 100 keV were used. Magnitudes of radiation yields and composition of the gaseous products and "polymeric" residue were determined by volumetric, gas-chromatographic, and gravimetric analyses. In the case of liquid benzene, G("polymer") decreases with increase in temperature, but G(gas) increases. It should be particularly noted that the values of G(gas) and G("polymer") for the case of gas-phase radiolysis of perfluorinated benzene do not differ significantly from the corresponding values for radiolysis of liquid C_6F_6. For ordinary benzene the value of $G(-C_6H_6) \simeq$ G("polymer") + G(gas) rises sharply on transition from liquid to vapor. The values of G("polymer") and G(gas) obtained for $C_{12}F_{10}$ indicate a high radiation stability for this compound up to 400°C. (auth)

11761 STEADY-STATE CONCENTRATIONS OF NITROUS ACID IN γ-IRRADIATED NITRIC ACID SOLUTIONS. Vladimirova, M. V.; Kulikov, I. A.; Savel'ev, Yu. I. This paper was summarized

in Khim. Vys. Energ.; 3: No. 6, 526-7(Nov-Dec 1969). (In Russian).

Full copy of this paper is held by DTIE.

The accumulation of nitrous acid in nitric acid solutions subjected to prolonged γ irradiation was studied. The G values for HNO_2 formation (molecules/100 eV) in HNO_3 solutions (absorbed dose 5×10^{17} to 5×10^{18} eV/ml) of various concentrations were determined, and a study made of the effect of radiation dose rate and partial nitric oxide pressure on the steady state concentration of HNO_2. (auth)

11762 EMISSION SPECTRA OF HYDROGEN ATOMS PRODUCED FROM METHANOL BY ELECTRON IMPACT. Fujita, Iwao (Osaka Univ.); Hatada, Motoyoshi; Ogawa, Teiichiro; Hirota, Kozo. Bull. Chem. Soc. Jap.; 44: No. 7, 1751-4(Jul 1971).

The emission spectra of several fragmental species, especially of hydrogen atoms, produced by the electron impact (energy: 240 eV) of gaseous methanol and deuteromethanols were investigated. The intensity ratios of the Balmer-β lines of the H and D atoms are ca 2.9 : 1 for CH_3OD and ca 1 : 1.8 for CD_3OH, indicating that the excited hydrogen atoms result from the O—H bond scission, as well as from the C—H bond scission, of the parent methanol molecules. The ratio of the scission probability of a C—H bond to that of the O—H bond is calculated to be 0.8, taking into account the correction of the isotope effect. It was concluded that the excited hydrogen atoms are produced by the primary process of fragmentation via a superexcited species. (auth)

11763 MEASUREMENT OF WATER AND OTHER OXYGEN-CONTAINING PRODUCTS IN THE RADIOLYSIS OF CYCLOHEXANE SOLUTIONS OF NITROUS OXIDE. Takeuchi, Ken-ichi; Shinsaka, Kyoji; Takao, Satoshi; Hatano, Yoshihiko; Shida, Shoji (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 44: No. 7, 2004 (Jul 1971).

The measurement of H_2O and other oxygen-containing products in the γ radiolysis of cyclohexane solutions of N_2O was carried out. Yields of H_2, N_2, ROH, $C_6H_{11}OH$, and H_2O are reported. It is concluded that the decomposition of N_2O leads finally to the formation of N_2 and ROH in the ratio of one to one. (J.G.B.)

11764 EFFECT OF HOLE SCAVENGERS ON THE RADIOLYSIS OF WATER . Sawai, Takeshi (Tokyo Metropolitan Isotope Research Center). Bull. Chem. Soc. Jap.; 44: No. 7, 1977-9(Jul 1971).

Evidence is presented for the trapping of holes produced in the radiolysis of water by halogen ions and SO_4^{2-}. The effects of solutes on the yield of molecular products were also studied. Results indicate that molecular products of the radiolysis of water are not formed by the reaction of the hole with dry electrons. (J.G.B.)

11765 STUDY OF THE RADIATION DEGRADATION OF POLYETHYLENE TEREPHTHALATE. Il'icheva, Z. F.; Slovokhotova, N. A. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 6, 528-9(Nov-Dec 1969). (In Russian).

Full copy of this paper is held by DTIE.

A study of the infrared and electronic spectra of polyethylene terephthalate (PET) that has been irradiated with fast electrons or with ^{60}Co γ radiation at the temperature of liquid nitrogen or close to it shows that radiation degradation of this polymer takes place by a mechanism of dissociative electron capture. On the basis of infrared spectra, the formation of CO_2 was detected (an absorption band at 2340 cm^{-1}), plus an increase in the amount of carboxyl groups (band at 3300 cm^{-1}) upon irradiation of PET even at 100°K. This indicates that radiation decarboxylation of the polymer, and also scission of its main chain with formation of carboxyl groups, takes place as the result of processes with activation energies close to zero. In the electronic spectra of PET irradiated at 77°K, the appearance of light-sensitive absorption bands in the 500 and 320 to 370 nm regions is observed, which correspond to the phthalate anion radical R $\leftrightarrows$ CO_2^-, which is formed as the result of dissociative electron capture by the carboxyl group of a monomer unit of the polymer. (auth)

11766 FORMATION OF CS_2^- IN THE γ RADIOLYSIS OF CS_2—3 MP GLASSY SYSTEM AT 77°K. Saha, S. K.; Iyer, R. M. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 11: No. 1, 19-22 (Oct 1971).

An intense optical absorption with λ_{max} at 275 nm in γ-irradiated CS_2—3MP (3-methylpentane) glasses observed at 77°K was found to be that of CS_2^- with an estimated molar extinction coefficient of 2.2×10^4 litre $mole^{-1}$ cm^{-1}. An additional absorption band observed at λ_{max} 372 nm was assigned to CS_2^+. The probable electronic transitions involved in CS_2^- and CS_2^+ is discussed. The effect of concentration of CS_2 and γ dose on the 275 and 372 nm bands was studied and their relevance is discussed. (auth)

11767 ELECTRON SPIN RESONANCE OF ACTIVE SPECIES PRODUCED IN GAMMA-IRRADIATED EPOXIDES AT -196°C. Nishimura, Hiromichi (Tokyo Univ.); Tabata, Yoneho; Oshima, Keichi; Tamura, Naoyuki. Kogyo Kagaku Zasshi; 74: No. 10, 2166-72(Oct 1971). (In Japanese).

Radical and ionic species produced in various monomers by γ irradiation at –196°C were studied using an electron spin resonance spectrometer. The measurements were carried out by means of matrix-isolation technique. Results with ethylene oxide that does not polymerize on irradiation, and with propylene oxide that is difficult to polymerize, are described. When these cyclic ethers were irradiated with γ rays at liquid nitrogen temperature in the dark, trapped electrons and radical species produced by hydrogen abstraction from the cyclic ethers could be observed. The former were bleached very easily by the irradiation with visible light, and the latter transformed into other radicals. In xenon matrices, these fragment radicals were observed to be stabilized. (auth) (Japan)

11768 EXCITONS AND MOLECULAR PRODUCT YIELDS IN LIQUID WATER. PART I. Gopinathan, C. pp 28-36 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

An attempt was made to explain molecular product yields and solute effects in liquid water through a mechanism not mainly based on diffusion of intermediates. Nemethy and Sheraga's extention of Frank and Wen's "flickering cluster" model was used to deduce quantitatively the molecular product yields. An exciton is expected to be created in a fast proton transfer reaction and react in pairs to give H_2O_2 and H_2. The G value for solvated electrons and estimates of HO yields are discussed. Experiments are suggested for verification of the model. (M.C.G.)

11769 EVIDENCE FOR TRIPLET EXCITONS IN THE RADIOLYSIS OF FROZEN AQUEOUS SYSTEMS. Moorthy, P. N. pp 37-9 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

The ESR spectrum of γ-irradiated 0.5 M H_2SO_4 was studied. Additions of $CoSO_4$ or $NiSO_4$ reduced the intensity of both the H atom doublet and the SO_4^- singlet very much. It was concluded that the primary species are triplet excitons that, in the presence of the paramagnetic transition metal ions, get quenched. (M.C.G.)

11770 ROLE OF GAS PHASE IONIC RECOMBINATION REACTIONS IN THE FORMATION OF EMBRYOS OF CONDENSATION NUCLEI. Vohra, K. G.; Nair, P. V. N.; Vasudevan, K. N. (Bhabha Atomic Research Centre, Bombay). pp 83-99 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

Experiments were carried out on radiolytic reactions consisting of specific ionic recombination reactions to study a possible mechanism of formation of condensation embryos. It is proposed that similar reactions can take place in the presence of water vapor, oxygen, solar radiation, and natural ionizing radiations. The trace gases used in the study are SO_2, Cl_2, and nitrogen oxides. Radiolysis of the gases during or after photolysis was studied. Evidence was found that radiolytic reactions of photolyzed gas mixtures are significant in the production of nuclei. (M.C.G.)

11771 RADIATION CHEMISTRY OF SYSTEMS OF BIOLOGICAL INTEREST. Singh, B. B. (Bhabha Atomic Research Centre, Trombay, India). pp 100-8 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

The role of short-lived transients in the properties of various compounds as radiosensitizers is discussed. Iodoacetamide and related compounds, N-ethylmaleimide and related compounds, and vitamin K_5 and its various analogs were studied. The roles of the hydrated electron and the hydroxyl radical in radiation sensitization are considered. (M.C.G.)

11772 RADIOLYSIS OF FERROUS-XYLENOL ORANGE SYSTEM IN ACIDIC SOLUTIONS. Gupta, B. L. (Bhabha Atomic Research Centre, Trombay, India). pp 115-25 of Proceedings

of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

Formation of the complex between Fe^{3+} and Xylenol Orange was studied in aqueous sulfuric acid solutions to estimate the number of ferric ions produced by radiolysis of a solution containing ferrous ions and Xylenol Orange. It is shown that solutions containing 10^{-4} M each of ferrous ions and Xylenol Orange in 0.05N sulfuric acid can be used to measure the radiation dose in the range 5 to 3000 rads using a calibration curve. Higher doses can be estimated when the concentration of Xylenol Orange in the solution is increased either before or after irradiation. (M.C.G.)

11773 RADIOLYSIS OF PLUTONIUM(III) IN AQUEOUS MEDIUM. Nagar, M. S.; Natarajan, P. R. (Bhabha Atomic Research Centre, Bombay). pp 126-30 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

The effects of ^{60}Co γ radiation on millimolar solutions of Pu(III) in 0.8N HCl in an argon atmosphere were investigated. The $G_{(Pu^{IV})}$ is between 4 and 5 up to a dose of about 6×10^{18} eV/ml and decreases at higher doses. The oxidation of Pu(III) to Pu(IV) may be explained by the following reactions: $OH + Cl^- + H^+ \rightarrow Cl + H_2O$ and $Pu(III) + Cl \rightarrow Pu(IV) + Cl^-$. (M.C.G.)

11774 RADIATION CHEMISTRY OF NITRIC ACID SOLUTION. Bhattacharyya, P. K.; Saini, R. (Bhabha Atomic Research Centre, Bombay). pp 131-6 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

It is shown that the net $G(HNO_2)$ decreases with dose when aqueous nitric acid (1M) is radiolyzed. The G values were considerably lower when radiolysis was carried out in the presence of air in comparison with those in an argon-swept solution. Results from γ radiolysis of HNO_3 showed that the radiolytic product HNO_2 increased with irradiation time and hence with dose. $G(HNO_2)$ decreased with irradiation time. This is assumed to be due to the reaction of H_2O_2 and HNO_2 formed on radiolysis. (M.C.G.)

11775 REACTION OF HYDRATED ELECTRONS WITH PERTECHNETATE. Mathur, P. K.; Venkateswarlu, K. S. (Bhabha Atomic Research Centre, Trombay, India). pp 137 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

11776 ELECTRON TRANSFER REACTION IN THE RADIATION CHEMISTRY OF SOME BIOLOGICALLY IMPORTANT DISULPHIDE COMPOUNDS. Lalitha, B.; Mittal, Jai P. (Bhabha Atomic Research Centre, Trombay, India). pp 138-46 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

Studies were made on the nature of the protective ability of disulfides at the molecular level by learning their behavior towards primary species produced in the radiolysis of water, the most abundant constituent of all biological systems. Solutions of cystine, cystamine, and glutathione were irradiated and results studied. (M.C.G.)

11777 EFFECTS OF ^{60}Co γ-RAY IRRADIATION ON L-THREONINE. Marathe, Savita V.; Korgaonkar, K. S. (Cancer Research Inst., Bombay). pp 147-53 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC-489; CONF-700214.

Solutions of L-threonine were irradiated using ^{60}Co γ radiation at 0.16 Mrad/hr. Ultraviolet and infrared spectrophotometric studies were made on the solutions. G values are given. (M.C.G.)

11778 GAMMA-IRRADIATION STUDIES WITH SYNTHETIC POLY-L-LYSINE-HYDROBROMIDE USING MONOLAYER TECHNIQUE. Joshi, S. V.; Korgaonkar, K. S. (Tata Memorial Centre, Bombay). pp 154-63 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

Poly-L-lysine hydrobromide samples were dissolved in distilled water and irradiated using ^{60}Co γ radiation. Changes in pH, uv spectra, and monolayer properties were studied. The pH of the solution decreased with increasing dose. The pressure–area curve was shifted to a lower area at the first dose, the next two higher doses shifted back to higher areas, and at the highest dose the effect was again reversed and a drastic reduction in area noted. (M.C.G.)

11779 APPLICATION OF ESR FOR THE STUDY OF RADIOLYSIS OF FROZEN AQUO-ORGANIC SYSTEMS. Moorthy, P. N.; Gopinathan, C.; Rao, K. N. pp 164-7 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

Studies using ESR methods were made of alcohols, ethers, and ketones radiolyzed in frozen aqueous systems. (M.C.G.)

11780 ENERGY TRANSFER STUDIES IN BENZENE SOLUTIONS OF METAL ACETYLACETONATES: FLUORESCENCE QUENCHING. Kalantri, O. P.; Srivastava, S. B. (Bhabha Atomic Research Centre, Trombay, India). pp 168 of Proceedings of the Symposium on Radiation Chemistry. Bombay; Bhabha Atomic Research Centre (1970).

From Symposium on radiation chemistry; Trombay, India (7 Feb 1970). See BARC–489; CONF-700214.

11781 γ-RADIOLYSIS OF ADSORBED METHANOL STUDIES BY THE EPR METHOD. Sorokin, Yu. A.; Tupikov, V. I.; Borisov, E. A. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 455-6(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

The γ radiolysis of CH_3OH, CH_3OD, and CD_3OH adsorbed on synthetic HY zeolites (cationized forms), NaY, CsY, and KSM grade silica gel was studied by the EPR method at 77°K. The radiolysis of the adsorbed CH_3OH, CD_3OH, and CD_3OD gave the radicals $\dot{C}H_2OX$, $\dot{C}D_2OX$, and $\dot{C}H_2OX$, respectively (where X is either H or D). Besides methanol radicals, H and D atoms are stabilized on hydrogen form during radiolysis of adsorbed CH_3OD and only H atoms during radiolysis of adsorbed CD_3OH and CH_3OH. It is assumed on the basis of the data obtained that methanol radicals are formed during breaking of the O–H or O–D bond in the hydroxyl group of alcohol with subsequent isomerization of the methoxyl radical $\dot{C}H_3O(\dot{C}D_3O)$ into the methanol radical $\dot{C}H_2OH(\dot{C}D_2OD)$. The radiation yield of these radicals is practically independent of the type and concentration of the zeolite cations in a wide range of surface filling of the sorbents. The radiolysis of methanol does not basically take place in the cations but in other adsorption centers. (auth)

11782 EPR STUDY OF THE STABILIZATION OF HYDROGEN ATOMS IN THE γ-RADIOLYSIS OF ADSORBED HYDROGEN-CONTAINING MOLECULES. Tupikov, V. I.; Sorokin, Yu. A. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 412(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

After irradiation of methanol, ethylene, acetylene, pyridine, and ammonia adsorbed on the zeolites NaA, HY, LiY, NaY, KY, and CsY, as well as ammonia and methanol adsorbed on SiO_2, the EPR spectrum of the hydrogen atoms was observed only in the radiolysis of the molecules adsorbed on the zeolite HY and SiO_2. The signals of stabilized hydrogen atoms were observed also on irradiating the zeolite HY (also SiO_2) containing no adsorbed molecules. However, the radiation yield of the stabilized hydrogen atoms was much lower in this case. Only the cation type distinguished the HY zeolite from the other zeolites used in this work. A reduction in the concentration of acid centers H^+ in the zeolite lattice by neutralizing them with some base (for example, pyridine, ammonia, or KOH) or by heating the HY zeolite above 700°K (whereby the zeolite is decationized) leads to a decrease in radiation yield (G) and stationary concentration (C) of the stabilized hydrogen atoms. The values of G(H) and C(H) for the cationized and decationized form of the zeolite with methanol, ethylene, and acetylene molecules absorbed on them, are shown. On the decationized HY zeolite, G(H) and C(H) are considerably smaller than on the cationized form. The acid centers H^+ are apparently present also on the SiO_2 surface treated with a weak HCl solution. Treatment of the SiO_2 surface with pyridine or a weak KOH solution leads to a sharp decrease in G(H) and C(H). The possible places of stabilization of the hydrogen atoms are discussed. A detailed description is given of the EPR spectrum of the absorbed hydrogen atoms. (auth)

11783 ENERGY-TRANSFER MECHANISM DURING RADIOLYSIS OF ADSORBED ETHYLENE AND ACETYLENE. Soro-

kin, Yu. A.; Tupikov, V. I.; Borisov, E. A.; Zakharov, V. F. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 457-8(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

The energy absorbed by the sorbent is known to be transmitted to the sorbate during γ radiolysis of adsorbed molecules. Experimental results are presented as a direct confirmation of an energy-transfer mechanism involving the participation of stabilized charges. The radicals formed when molecules were adsorbed on previously γ-irradiated sorbents were compared with those formed during the radiolysis of adsorbed molecules (with an irradiation temperature of 77°K). The sorbent was usually zeolite of type NaY (HY in some cases), while the sorbate was ethylene (99.9% pure) or acetylene (98%) containing no oxygen. The EPR spectra of the γ-irradiated NaY and HY zeolites consisted of a singlet about 30 Oe wide. Stabilized electrons and, apparently, stabilized holes were responsible for this singlet. Bringing ethylene at 77°K into contact with zeolite (NaY and HY) irradiated at this temperature and then thawing the specimen to 183°K caused a change in the EPR spectrum. A multicomponent spectrum developed in place of the original singlet spectrum of the irradiated zeolite. Ethylene or acetylene, which has a negative electron affinity, is adsorbed in the vicinity of the positive holes produced in zeolites by γ radiation. The electrons are freed from the traps and recombine with the positive charges when the specimen temperature is raised. Charge recombination was established from the decrease in the integral intensity of the EPR spectrum produced by these charges. The energy liberated in charge neutralization leads to rupture of the C−H bonds in the adsorbed molecules, forming hydrocarbon radicals and hydrogen atoms; the latter either attached to adjacent hydrocarbon molecules or recombine with one another and thus give no EPR spectrum. Irradiation of NaY zeolite with previously adsorbed C_2H_4 and C_2H_2 molecules (with a packing of two sorbate molecules for each large cavity in the sorbent) produced the same radicals as adsorption of C_2H_4 and C_2H_2 on preliminarily irradiated zeolite. (auth)

11784 PROPERTIES OF FREE RADICALS FORMED DURING IRRADIATION OF POTASSIUM NITRATE. Poleshchuk, N. M.; Raitsimring, A. M.; Tsvetkov, Yu. D.; Boldyrev, V. V. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 458-9(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

The kinetics of radical decay in potassium nitrate subjected to γ irradiation at 77°K were studied and the radiation yields determined. Since two types of radicals are formed under the irradiation conditions in question (77°K and an absorbed dose of 10^{20} eV/g or less), KNO_3 single crystals were used as specimens, which made it possible to obtain good resolution of the radical EPR spectra and to distinguish the individual spectrum components for each type of radical. Irradiation was carried out with ^{60}Co γ rays (at a dose rate of 3.6 Mrad/h) at 77°K. Investigation of the relative temperature stability of the radicals (annealing curves) showed that the NO_3^{2-} and NO differed in thermostability; while the NO_3^{2-} began to decay at 77°K, the NO radical was stable to about 160°K. The decay kinetics of the NO_3^{2-} radical were studied over the temperature range 77 to 162°K. The kinetic curves were well described by the bimolecular rule with the reaction-rate constant $k = (0.7 \pm 0.2) \cdot 10^{-17} \exp(1800 \pm 300)/RT$ cm^3 sec^{-1} (the activation energy is in cal/mole). In order to explain the decay mechanism for the NO_3^{2-} ion radical, it was assumed that it recombines with a positively charged defect, whose concentration should be equal to the NO_3^{2-} concentration. However, the value of the preexponential multiplier for this reaction is six or seven orders of magnitude below normal, which indicates a diffusive decay mechanism. The decay kinetics for the NO radical are described by a first-order kinetic equation over the temperature range 180 to 215°K. The preexponential multiplier and the activation energy of decay were found to be $k_0 = (2.5 \pm 0.5) \cdot 10^5$ sec^{-1} and $E = (7300 \pm 500)$ cal/mole, respectively. It was assumed that the disappearance of this radical is due to its diffusion out of the crystal into the gaseous phase. The radiation yields of the radicals were found to be $G(NO) \approx G(NO_3^{2-}) = 0.15$. Most of the molecular product is formed during the early stages of the radiolysis of potassium nitrate. (auth)

11785 TEMPERATURE DEPENDENCE OF THE RADIOLYSIS OF RUBIDIUM NITRATE DURING IRRADIATION WITH PROTONS. Eremin, L. P.; Oblivantsev, A. N.; Boldyrev, V. V. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). This paper was summarized in Khim. Vys. Energ.; 3: No. 6, 529-30 (Nov-Dec 1969). (In Russian).

Full copy of this paper is held by DTIE.

The temperature dependence of the formation of NO_2^- (determined by chemical analysis) during the radiolysis of $RbNO_3$ tablets (chemically pure) by protons of energy 5 MeV (irradiation in a cyclotron) was studied. The temperature dependence $G(NO_2^-)$ has a minimum in the region of polymorphous transition at 164° and a change in the shape of the curve in the vicinity of the transition at 219°C. The effect of pressure pressing and preliminary heating of the samples on the appearance of polymorphous transitions during the radiolysis can be considered as evidence of the fact that lattice defects take part in the radiolysis of $RbNO_3$. They have a special effect on the reverse bimolecular radiolysis processes, accelerating them, and, at the same time, decreasing the yield, which is most notable during polymorphous transitions. Thus, the increase in the pressure during pressing of the tablets, which creates a large concentration of defects, correspondingly decreases the minimum in the transition range 164°C. Preliminary heating of the samples, which decreases the concentration of defects in the crystals, has just the opposite effect. Annealing of the defects occurs more intensely in the polymorphous transition regions and at high temperatures. Thus, more prolonged preliminary heating at the relatively low temperature 115° does not change the yield over the entire range of irradiation temperatures, but comparatively brief heating in the transition temperature range 164°C leads to increased yields. (auth)

11786 RADICAL REACTIONS OF N-ETHYL MALEIMIDE IN RADIATION SENSITIZATION. Simic, M. (Univ. of Texas, Austin); Hayon, E. Int. J. Radiat. Biol.; 20: No. 6, 589-92 (1971).

Pulse radiolysis studies of N-ethylmaleimide (NEM) reactions with various free radicals are reviewed. It was found that NEM was not only a good electron acceptor from radical anions, but a powerful acceptor for a number of neutral organic free radicals produced by reaction of OH radicals or H atoms with organic solutes (e.g., isopropanol, ribose, methanol, N-methylacetamide). NEM also appeared capable of reacting with various free radical sites, resulting in an additional reaction across the double bond of the sensitizer. It is tentatively suggested that the sensitization mechanism of NEM with DNA may be oxidation of the sugar radicals and addition of NEM. (UK)

11787 PULSE RADIOLYSIS AND INACTIVATION OF TRYPSIN. Masuda, T.; Ovadia, J.; Grossweiner, L. I. (Michael Reese Hospital, Chicago). Int. J. Radiat. Biol.; 20: No. 5, 447-59(1971).

Pulse radiolysis of aqueous trypsin with 33-MeV electrons was used to identify the initial products with the OH radical and H atom adducts to tryptophan residues, and the electron adduct to cystine residues. Essentially, all OH reacted with tryptophan in the initial stage, with $k(OH + \text{trypsin}) = 8.2 \pm 1.2 \times 10^{10}$ M^{-1} sec^{-1}. The disulphide bond electron adduct accounted for about 60 percent of the primary electron yield, where $k(e^-_{aq} + \text{trypsin}) = 3.5 \pm 0.8 \times 10^{10}$ M^{-1} sec^{-1}. Measurements of tryptophan residue loss and sulphhydryl formation under different irradiation conditions showed that the attack of OH radicals was partially reversed, except in the presence of oxygen, and that the permanent reduction of cystine residues was small compared with the initial yield and negligible when oxygen was present. There was no significant difference between the initial radiolysis reactions and permanent residue changes in trypsinogen and the active enzyme. The inactivation G value could be expressed as $\Sigma f_i g_i$ where g_i is the primary yield of species i under the irradiation conditions, and f_i is the probability that the attack of species i inactivates a trypsin molecule. A good fit obtained at pH 2.1 and pH 7.4 under all irradiation conditions investigated for: $f_c = 0.09$, $f_{OH} = 0.05$, $f_H = 0.10$, $f_{H_2O_2} = 0.04$, $f_{HO_2} = 0.04$, and $f_{O_2^-} = 0.03$. The inactivation of trypsin by many radicals with low independent probabilities was explained by postulating that only a small fraction f_i of the primary reactions influence the integrity of the active center. (auth)

11788 GASEOUS PRODUCTS ON THE IRRADIATION OF METHYLCYCLOHEXENES. Cserep, Gy.; Reitberger, T. (Royal Inst. of Tech., Stockholm). Radiochem. Radioanal. Lett.; 8: No. 6, 333-40(31 Dec 1971).

The G values of gaseous products formed upon γ-irradiation of isomeric methylcyclohexenes were determined by analyzing yields on a gas burette combined with a Toepler pump, the various components being identified by gas chromatography. The main fragmentation seems to take the form of a "retro Diels–Adler reaction" with a favored fission of σ-bonds in β position relative to the double bond. Irradiations were carried out with the isomers in the liquid and solid (vitreous) state. The general pattern of reaction does not change with the state of the isomer. (auth)

11789 SECOND SYMPOSIUM ON ELECTRON SPIN RESONANCE SPECTROSCOPY, ATHENS, GEORGIA, DECEMBER 7–9,

1970. J. Phys. Chem.; 75: No. 22, 3383-491(28 Oct 1971). (CONF-701221).

Separate abstracts were prepared for five of the fourteen papers presented. (D.H.M.)

For abstracts of individual papers see: 11693 and 11790–11793.

11790 SPIN TRAPPING OF SOME SHORT-LIVED RADICALS BY THE NITROXIDE METHOD. Lagercrantz, Carl (Univ., Goteborg). J. Phys. Chem.; 75: No. 22, 3466-75(28 Oct 1971).

From second symposium on electron spin resonance spectroscopy; Athens, Georgia (7 Dec 1970).

The scavenger properties of tert-alkylnitroso compounds were used for the trapping of short-lived free radicals as stable nitroxide radicals. As well as the main triplet splitting caused by the nitrogen nucleus of the nitroxide group, the ESR spectra showed secondary splittings which originated from magnetic nuclei of the part of the nitroxide derived from the trapped radical. From these splittings it was in many cases possible to determine the structure of the trapped radical. (auth)

11791 ELECTRON SPIN RESONANCE STUDY OF THE IO_2F^- RADICAL IN γ-IRRADIATED SINGLE CRYSTALS OF POTASSIUM OXYFLUOROIODATE. Subramanian, S.; Rogers, Max T. (Michigan State Univ., East Lansing). J. Phys. Chem.; 75: No. 22, 3479-85(28 Oct 1971).

From second symposium on electron spin resonance spectroscopy; Athens, Georgia (7 Dec 1970).

Single crystals of KIO_2F_2 γ-irradiated at room temperature, or irradiated at 77°K and allowed to warm above 140°K, give ESR spectra characteristic of the 27-electron radical anion IO_2F^-. The g, $A(^{19}F)$, and $A(^{127}I)$ tensors were evaluated, and the ^{127}I quadrupole interaction parameters Q' and Q'' were estimated from the spectra. The unpaired electron is predominantly delocalized over the iodine and oxygen atoms and interacts only weakly with the fluorine atom. The possible structure of the radical ion is discussed. (auth)

11792 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF PYRROLIDINO AND PYRROLINO FREE RADICALS. THE STRUCTURE OF DIALKYLAMINO RADICALS. Pratt, David W. (Univ. of Pittsburgh); Dillon, John J.; Lloyd, Roger V.; Wood, David E. J. Phys. Chem.; 75: No. 22, 3486-9(28 Oct 1971).

From second symposium on electron spin resonance spectroscopy; Athens, Georgia (7 Dec 1970).

The nitrogen-centered free radicals pyrrolidino and pyrrolino were prepared by x irradiation of the corresponding amines in an adamantane matrix at 77°K. At temperatures near 200°K, the radicals undergo rapid reorientation in the matrix and exhibit isotropic EPR spectra. Comparison of the ^{14}N hyperfine splittings and g values of these radicals with those found for several open-chain dialkylamino radicals indicates that all of these species appear to have similar electronic structures and RNR bond angles of less than 120°. This view is supported by steric considerations in the case of the cyclic radicals and by INDO calculations on the dimethylamino radical which show that the eclipsed form with a CNC bond angle of 117° is the most stable conformation. These calculations also indicate that $(CH_3)_2N\cdot$ is a π radical with very little σ character and predict hyperfine splittings in good agreement with the experimental values. (auth)

11793 ELECTRON SPIN RESONANCE STUDY OF X-IRRADIATED LONG-CHAIN ALCOHOLS ORIENTED IN UREA INCLUSION CRYSTALS. Birrell, G. Bruce; Griffith, O. Hayes (Univ. of Oregon, Eugene). J. Phys. Chem.; 75: No. 22, 3489-91(28 Oct 1971).

From second symposium on electron spin resonance spectroscopy; Athens, Georgia (7 Dec 1970).

Single crystals of the 6-undecanol–urea and 1-decanol–urea inclusion compounds were x-irradiated at 77°K, and the resulting free radicals were examined using electron spin resonance techniques. In both cases the long-lived radicals were those formed by removal of a hydrogen atom from the carbon attached to the OH group. (auth)

11794 PULSE RADIOLYSIS OF ALCOHOL GLASSES AT 77°K: MECHANISM OF ELECTRON TRAPPING. Kevan, Larry (Wayne State Univ., Detroit). J. Chem. Phys.; 56: No. 2, 838-44(15 Jan 1972).

Ethylene glycol–water (50–50), methanol–water (95–5), ethanol, 1-propanol, 2-propanol, and 2-propanol–methyltetrahydrofuran (50–50) glasses were studied by pulse radiolysis at 77°K. In each glass a trapped electron spectrum is observed which shifts toward the blue on a microsecond timescale. This suggests a shift from shallow to deeper traps. The spectral shift appears to occur more rapidly in more polar matrices. This is the opposite of the direction expected based on relative matrix viscosities. When 10^{-2} M biphenyl or benzyl chloride is added to 2-propanol glass about 40% of the electrons are scavenged. The resulting biphenyl anion and benzyl radical spectra show no transient changes in intensity after the pulse while the residual trapped electron spectrum shows the same shift as before. Both the polarity and the solute effects indicate that molecular reorientation around the electron is responsible for the transient spectral shift. A short-range electron–matrix interaction would presumably cause faster reorientation in more polar matrices. An alternative mechanism of a redistribution of electrons among shallow and deep preformed traps seems to be ruled out. (auth)

11795 ESR SPECTRUM OF O_3^- TRAPPED IN A SINGLE CRYSTAL OF POTASSIUM CHLORATE. Schlick, S. (Israel Inst. of Tech., Haifa). J. Chem. Phys.; 56: No. 1, 654-5 (1 Jan 1972).

The O_3^- radical obtained by x irradiation of ^{17}O-enriched $KClO_3$ was studied by ESR. The molecule is trapped at three distinct sites in the potassium chlorate single crystal, one of which gives rise to a more intense ESR spectrum. For O_3^- at the dominant trapping site, the principal values of the g tensor are 2.0035, 2.0187, and 2.0123. Two distinct ^{17}O hyperfine splittings were observed and their variation as a function of orientation studied. The principal values of the corresponding hyperfine tensors are 82.6, –8, –8 and 43.6, –5, –5 G. The direction of the maximum principal value for both ^{17}O hyperfine tensors coincides with the direction of the minimum principal value of the g tensor, as expected for a bent 19-electron molecule. The higher splitting is assigned to the central atom and the lower splitting to the magnetically equivalent outer atoms. The spin density distribution in O_3^- deduced from experimental data is compared with theoretical results obtained from a CNDO/II calculation. The g values for O_3^- at the less populated sites are practically identical to the g values given above. Oxygen-17 hyperfine splittings observed from O_3^- at these sites seem to indicate a slight distortion of the molecule, possibly from C_{2v} to C_s symmetry. All magnetic parameters were measured at 77°K. (auth)

11796 ION–MOLECULE REACTION CHAINS IN ISOBUTENE. Sieck, L. W.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys.; 56: No. 2, 1010-11(15 Jan 1972).

The formation of products obtained in the vapor and condensed phase radiolysis and photoionization of isobutene in closed systems has been widely interpreted exclusively in terms of the formation and subsequent reactions of $C_4H_9^+$ from the reaction $i\text{-}C_4H_8^+ + i\text{-}C_4H_8 \rightarrow C_4H_9^+ + C_4H_7$ (1). The observation of an equally important reaction channel at 300°K for thermal $i\text{-}C_4H_8^+$ ions is reported that results in the formation of stable dimer ions $i\text{-}C_4H_8^+(i\text{-}C_4D_8^+) + i\text{-}C_4H_8(i\text{-}C_4D_8) \rightarrow C_8H_{16}^+(C_8D_{16}^+)$ (2). It was concluded that reaction (1) may still be of sufficient importance to account for the radiation induced polymerization of liquid isobutene but reaction (2) will certainly contribute significantly to the chemical end products. (D.H.M.)

11797 ESR OF AN ALKYLALKOXYAMINO RADICAL TRAPPED IN X-IRRADIATED DECANAL OXIME O-METHYL ETHER–UREA INCLUSION CRYSTALS. Ciecierska-Tworek, Zofia; Birrell, G. Bruce; Griffith, O. Hayes (Univ. of Oregon, Eugene). J. Chem. Phys.; 56: No. 2, 1001-3(15 Jan 1972).

A study is reported of a new alkylalkoxyamino radical formed by x-irradiating decanol oxime O-methyl ether, $CH_3(CH_2)_8\text{–}CH{=}NOCH_3$, oriented in a urea inclusion crystal. The crystals were x-irradiated at 77°K and spectra were recorded at room temperature. ESR spectra obtained immediately after x irradiation are complex and indicate the presence of more than one radical. However, after subjecting the inclusion crystal to uv light for several hours, it was possible to isolate one of the radicals. From the data it was concluded that the radical found was $CH_3(CH_2)_8\text{–}CH_2\text{–}\dot{N}\text{–}O\text{–}CH_3$. (D.H.M.)

11798 PHOTOCONVERSION OF FREE RADICALS IN POLYMERS. III. FREE RADICALS IN POLY-ε-CAPROAMIDE. Kiryukhin, V. P.; Milinchuk, V. K. (Inst. of Physical Chemistry, Moscow). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 451(Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

Under the action of uv light, radicals with the structure

$$\sim CH_2\overset{O}{\overset{\|}{C}}NH\dot{C}HCH_2 \sim \ (R_1),$$

which are formed as a result of radiolysis of polycaproamide, are transformed into radicals that correspond to a sextet with about 30 Oe spacing between the hyperfine structure components and a single line with $\Delta H \cong 17$ Oe and $g = 2.0044$. The unpaired electron of the electron-excited radical R_1 can migrate through the C=C bonds and form the radicals $\sim CH_2\dot{C}HCH_2 \sim$

(R_2), which are responsible for the sextet. The transfer of the radical center in the macromolecule through the peptide bonds, which is accompanied by isomerization of the double bond and migration of the hydrogen atom from the nitrogen atom to the C_1 or C_2 atom, results in the formation of radicals in which free valence is localized on the oxygen atom. The formation of this radical may occur also during the migration of the unpaired electron from the side of the carbon chain. In the process of successive irradiation with uv and visible light, the critical concentration of the radicals gradually decreases and the radicals R_2 accumulate. An increase in the temperature at which the exposure to light is performed reduces the rate and critical degree of photoconversion of R_1. At temperatures ≥170°K the photoconversion of R_1 is not observed. On irradiation with light in the 77 to 300°K temperature range, the concentration of the radical does not change. In the process of photoconversion the radicals can be in the oscillation-excited state. In polycaproamide the migration of free valence is apparently restricted within one or two monomer units, for which reason the radicals cannot come sufficiently near for recombination. In the electron spectrum of γ-irradiated polycaproamide the absorption band with $\lambda_{max} \cong 370$ nm is attributed to R_1. (auth)

11799 INFRARED SPECTRUM OF POLYETHYLENE IRRADIATED AT 4°K. Waterman, David C. (Northwestern Univ., Evanston, Ill.); Dole, Malcolm. J. Phys. Chem.; 75: No. 26, 3988-92(23 Dec 1971).

Both ultraviolet and infrared measurements were made at 4°K on a high-density polyethylene after irradiation with 1-MeV electrons at 4°K. No significant changes were observed in the uv spectrum due to the irradiation. On warming to 77°K, a small shoulder appeared at 258 nm equivalent to about 4% of the allyl free radical ultimately formed after annealing at room temperature. In the ir spectra, two overlapping absorption bands at about 973 and 966 cm^{-1} were produced at 4°K, but on warming to 77°K the two bands were transformed into the single sharp band characteristic of the vinylene group at 966 cm^{-1}. The total area of the double band was almost exactly equal to that of the single band. The new band at 973 cm^{-1} is tentatively assigned to the transient, the $-CH=C^{+}H-$ ion. Irradiations at 77°K with subsequent heating to room temperature demonstrated that there is no decay of the trans-vinylene group during low-temperature irradiations. (auth)

11800 PULSE RADIOLYSIS STUDY ON RADICAL IONS OF STYRENE. Yoshida, Hiroshi; (Kyoto Univ., Osaka); Noda, Masato; Irie, Masahiro. Polym. J.; 2: No. 3, 359-63(May 1971).

Pulse radiolysis investigation was carried out on solutions of styrene in 2-methyltetrahydrofuran and n-butyl chloride with 1.0 μsec electron pulses (15 MeV) at room temperature. Styryl radicals and radical anions formed from the solute were observed from the former solution. In addition to the styryl radicals, the absorption band (λ_{max} = 350 nm) of cation radicals was observed in the n-butyl chloride solution. These radicals are formed by the positive charge transfer from the solvent to the solute styrene, and disappear mainly with the 2nd order kinetics by recombining with anionic intermediates. However, in the later period, their decay deviates from the 2nd order kinetics. This results from the superposing 1st order reaction with rate constant of about 2×10^6 $mole^{-1}$ l sec^{-1}, probably due to the addition of styrene to the radical cations. These results are discussed with respect to the initiation process in radioinduced cationic polymerization of styrene. (auth) (Japan)

11801 STUDIES ON THE FORMATION OF PRIMARY YIELDS OF HYDROGEN PEROXIDE AND MOLECULAR HYDROGEN ($G_{H_2O_2}$ AND G_{H_2}) IN THE γ RADIOLYSIS OF NEUTRAL AQUEOUS SOLUTIONS. Draganic, Z. D.; Draganic, I. G. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Phys. Chem.; 75: No. 26, 3950-7(23 Dec 1971).

The formation of $G_{H_2O_2}$ and G_{H_2} was studied in γ-irradiated aqueous solutions containing selected mixtures of scavengers for both oxidizing and reducing primary free radicals. Experimental verification was made of various assumptions based on the free-radical model of water radiolysis. It was confirmed that efficient scavenging of OH radicals not only reduces $G_{H_2O_2}$ but also increases G_{H_2} by depressing the extent of water-reforming reactions and making more e^-_{aq} available for increased H_2 formation. Similarly, it was shown that the removal of e^-_{aq} leads not only to a decrease in G_{H_2} but also to an increase in $G_{H_2O_2}$. These effects are additive, and empirical relations were proposed to correlate the expected primary molecular yields with the reactivities toward OH and e^-_{aq}. Unifying curves were obtained for the dependence of observed fractional yield changes, G_M/G_M^i, on reactivities. They point out that the secondary spur reactions of radicals with products of radical–solute scavenging reactions are rather exceptions even at solute concentrations of about 1 M and reactivities of 10^{10} sec^{-1}. (auth)

11802 ESR STUDY OF THE CH_2Cl RADICAL IN A SINGLE CRYSTAL OF CH_3Cl. Michaut, J. P.; Roncin, J. (Paris Univ., Orsay, France). Chem. Phys. Lett.; 12: No. 1, 95-7(1 Dec 1971).

Paramagnetic resonance spectra of the $\dot{C}H_2Cl$ radical produced by γ irradiation of a methyl chloride single crystal have been studied. From the coupling tensors of the hydrogen and chlorine, and the electric quadrupole tensor of chlorine, it has been shown that $\dot{C}H_2Cl$ has a nearly planar structure. (auth)

11803 RADIATION CHEMISTRY OF HEXAFLUOROACETONE IN THE GAS PHASE. Chang, Cherng. Gainesville, Fla.; Univ. of Florida (1970). 168p. University Microfilms Order No. 71-24,415.

Thesis.

The ^{60}Co γ radiolysis of hexafluoroacetone (HFA), indexed as hexafluoro-2-propanone, in the gas phase was studied at 400 Torr and room temperature. All radiolyses were carried out in a 99-ml nickel vessel. There were 21 products found in the gas chromatograph with a dose of 5×10^{20} eV or less. Except CO and several minor products, all the rest can be classified into three categories according to their functional groups: perfluoroalkanes (CF_4, C_2F_6, C_3F_8, C_4F_{10}, C_5F_{12}, and C_6F_{14}), perfluoro ethers ($C_4F_{10}O$, $C_5F_{12}O$, $C_6F_{14}O$, and $C_9F_{20}O_2$); perfluoro keto ethers ($C_6F_{12}O_2$, $C_7F_{14}O_2$, $C_8F_{16}O_2$, $C_9F_{18}O_3$, and $C_{10}F_{20}O_3$). The yields of most of these products were measured in terms of their G values or relative G values. For comparison with the present radiolysis results, two types of mass spectrometric studies were made on HFA. The first type of work was the mass spectral analysis of hexafluoroacetone. A reaction mechanism was proposed to explain the fragmentation of the parent ion $CF_3COCF_3^+$. The second type of work was the study of ion–molecule reactions of HFA. A set of ion-molecule reactions was proposed to explain the experimental observation. Rate constants for several ion–molecule reactions were obtained. A reaction mechanism involving both free radical and ion–molecule reactions was proposed for the radiolysis of HFA. All products were accounted for satisfactorily by this mechanism except C_4F_8O, whose structural formula is still not clear at present. It is interesting to find that the results of both the mass spectral fragmentation pattern and the ion–molecule reactions of HFA as found in the mass spectrometric studies can be applied to the interpretation of the present radiolysis system with considerable success. It was proposed that all perfluoroalkanes were mainly formed through radical–radical combinations; and perfluoro ethers and perfluoro keto ethers resulted from ion–molecule condensation reactions followed by some reasonable neutralization processes. The yields of several major radicals and ions were estimated by comparison of the G values of the radiolysis products of HFA. Calculation also indicated that approximately 50% of the CO is formed from the ionic fragmentation process, with the rest produced by the decomposition of the neutral HFA in the excited state. Several radiolyses were also done for mixtures of HFA and iodine. The radical–radical combination products such as C_2F_6, C_3F_8, and C_4F_{10} were largely depressed. (Diss. Abstr. Int., B)

11804 ION YIELDS AND ION NEUTRALIZATION PROCESSES IN PULSE-IRRADIATED ACETONE. Chaudhri, Shamim A.; Asmus, K.-D. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). J. Phys. Chem.; 76: No. 1, 26-31(6 Jan 1972).

Ion yields and ion neutralization processes were studied in pulse-irradiated acetone solutions using optical and conductivity methods. The yield of free $(CH_3)_2CO^-$ ions was determined to be $G_{fi} = 1.20 \pm 0.20$ by conductivity measurements. Tetranitromethane is reduced by $(CH_3)_2CO^-$ ions to form $C(NO_2)_3^-$ ions with $k = 1.2 \times 10^{10}$ M^{-1} sec^{-1}. Nitroform ions are neutralized by solvated protons with $k = 3.6 \times 10^8$ M^{-1} sec^{-1}, and $C(NO_2)_3H$ dissociates with 1.6×10^3 sec^{-1}. The equilibrium constant of $C(NO_2)_3H \rightleftharpoons C(NO_2)_3^- + H^+_{sol}$ in acetone was determined to be 4.5×10^{-6} M. The yields of homogeneously distributed $C(NO_2)_3^-$ anions, anthracene anions, and chloride ions from the reduction of tetranitromethane, anthracene, and carbon tetrachloride, respectively, exceed $G_{fi}((CH_3)_2CO^-)$. The influence of equilibrium conditions and possible activation energies on the neutralization process are discussed. Equivalent conductances have been determined for $C(NO_2)_3^-$ ions (Λ = 130 Ω^{-1} cm^2 $equiv^{-1}$) and anthracene anions (Λ = 135 Ω^{-1} cm^2 $equiv^{-1}$) in acetone. (auth)

11805 REDUCTION WITH TRICHLOROSILANE. III. CYCLIC ETHER FROM LACTONE. Nakao, Ren; Fukumoto, Tsugio; Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture, Osaka). J. Org. Chem.; 37: No. 1, 76-8(14 Jan 1972).

The reduction of γ, δ, and ϵ lactones to the corresponding cyclic ethers by means of trichlorosilane is described. The reaction was initiated by γ and uv irradiations and photoinduced decomposition of tert-butyl peroxide. This method yielded cyclic ethers in comparatively high yields except for the β lactone which was found to suffer ring opening. (auth)

11806 RADIATION CHEMISTRY OF HYDROCARBONS. PART 19. DEUTERIUM ABSTRACTION IN ISOTOPE ISOMERS OF CYCLOHEXANE. Ballenegger, M.; Ruf, A.; Gaeumann, T. (Institut fuer Physikalische Chemie, Lausanne, Switzerland). Helv. Chim. Acta; 54: No. 5, 1373-9(1971). (In German).

The G-value for D_2 production was measured for C_6D_{12} and for gem-, cis-, and trans-$C_6H_{10}D_2$. The G-values for the unimolecular process are 0.24, 0.023, 0.010, and 0.004, respectively. In C_6D_{12} two bimolecular processes can be distinguished: one includes "hot" D-atoms, e.g., a species that shows no isotope effect for the hydrogen abstraction yielding D_2 and HD; its G-value is 1.22. The other process goes via thermal D-atoms, it has a G-value of 1.97 and gives an isotope effect for abstraction: $k_D/k_H = 0.075$ (10°C). In the partially deuterated cyclohexanes, only the former process was observed. Its G-value depends on the irradiation temperature and phase, is independent of the position of the D-atoms in the molecule and amounts to 0.035 (10°C), 0.028 (–40°C solid), 0.040 (–40°C liquid with 25% hexane). The following conclusions can be drawn: the unimolecular detachment shows no intramolecular isotope effect in partially deuterated molecules and comes only from the gem-, cis-, and trans-positions. Most of the G-values for the D_2 and HD production by different reaction paths can be cross-checked by G-values from different mixtures. The agreement between these values is excellent. (auth)

11807 RADIOLYSIS OF HYDROCARBON MIXTURES. Roder, M. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 337-41 (Jul-Aug 1971). (In Hungarian).

Gaseous products of the radiolysis of mixtures of hexamethylbenzene with cyclohexane, benzene, and toluene, respectively, were investigated as a function of composition. The interactions between components of mixtures under the effect of radiation are mainly of physical character (energy and charge transfer). (auth)

11808 INVESTIGATION OF RADIOLYSIS OF CYCLOALKANE–n-ALKANE–ISOALKANE MIXTURES. Gyorgy, L.; Horvath, Zs.; Wojnarovits, L.; Foldiak, G. (Magyar Tudomanyos Akademia Izotop Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 332-6(Jul-Aug 1971). (In Hungarian).

In mixtures of normal chain–branched chain hydrocarbons yields, as a rule, differ from those calculated on the basis of the linear mixing rule. When one of the components of a mixture has a cyclic structure, the "protecting effect" is, as a rule, weak. (auth)

11809 EFFECT OF CYCLIC STRUCTURE ON THE RADIATION CHEMICAL DECOMPOSITION OF HYDROCARBONS. Wojnarovits, L.; Foldiak, G. (Magyar Tudomanyos Akademia Izotop Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 328-30(Jul-Aug 1971). (In Hungarian).

By investigating radiation-chemical ring-opening reactions of C_3 to C_8 cycloalkanes and cycloalkenes it was established that the amount of light hydrocarbon product decreased with increasing number of carbon atoms in the rings. (auth)

11810 EFFECT OF CYCLIC STRUCTURE ON RADIOLYTIC DECOMPOSITION OF GASEOUS HYDROCARBONS. Horvath, Zs. (Magyar Tudomanyos Akademia Izotop Intezete, Budapest); Foldiak, G.; Gruber, L. Izotoptechnika; 14: No. 7-8, 324-7 (Jul-Aug 1971). (In Hungarian).

In the radiation-chemical decomposition of hydrocarbon rings with 3 and 4 carbon atoms, as opposed to rings with higher numbers of carbon atoms, the decomposition of C–C bonds proved to be the most important radiation-chemical reaction. (auth)

11811 DIRECTING EFFECT OF π-BONDS ON THE RADIOLYSIS OF SEVERAL MONOALKENES. Cserep, Gy.; Foldiak, G. (Magyar Tudomanyos Akademia Izotop Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 318-23(Jul-Aug 1971). (In Hungarian).

π-Bonds weaken σ-bonds in the β-position to them. On the basis of the measured G_{H_2} values, the hydrogen evolution as a function of molecular structure was studied. (auth)

11812 EFFECT OF CHEMICAL STRUCTURE ON THE RADIATION CHEMICAL YIELD OF HYDROCARBONS. Foldiak, G. (Magyar Tudomanyos Akademia Izotop Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 314-17(Jul-Aug 1971). (In Hungarian).

Alkenes influence the G_{H_2} values of their mixtures with saturated hydrocarbons according to their chemical structure. In the case of unsaturated hydrocarbons of the same bond type, the G_{H_2} value of mixtures of saturated–unsaturated hydrocarbons is more or less unambiguously determined by the π-bond concentration of the sample. (auth)

11813 RADIOLYSIS OF WATER AND AQUEOUS SOLUTIONS IN THE PRESENCE OF STABLE FREE RADICALS. Putirszkaja, G. V.; Matus, L. (Magyar Tudomanyos Akademia Kozponti Kemiai Kutato Intezete, Budapest). Izotoptechnika; 14: No. 7-8, 310-13(Jul-Aug 1971). (In Hungarian).

Water and aqueous solutions were studied by means of free radicals of relatively high molecular weight. Free radicals participate not only in radical capture reactions but also in others. (auth)

11814 INVESTIGATION OF THE RADIOLYTIC REACTION BETWEEN GRAPHITE AND CO_2 WITH ADDITIVES AT TEMPERATURES UP TO 740°C USING ^{14}C-LABELLED GRAPHITE. Labaton, V. Y. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 277 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

A study was made of the radiolytic reaction at 550 to 740°C, using a ^{14}C-labelled technique, with the object of determining the relative effects of the thermal and radiolytic components. It was assumed that these components are additive. Over a large part of the temperature range it was apparent that the radiolytic reaction was a major part of the overall reaction; only with pure CO_2 was the thermal factor more significant, particularly at the highest temperatures investigated. For the various gas mixtures investigated there was a marked effect of temperature on reaction rate above 600°C, but in the case of CO_2 the effect of temperature was less marked and between 350 and 600°C only a small increase in reaction rate with temperature was observed. Inhibition factors were determined for dry CO–CO_2, wet CO–CO_2, and wet and dry mixtures containing CH_4. Inhibition factors decreased with increasing temperature, and reaction rates tended to converge at the higher temperatures. The results indicated that the effects of temperature can be expressed in terms of an Arrhenius-type equation. Temperature coefficients of reaction were calculated in terms of apparent activation energies. (UK)

11815 RADIATION-INDUCED REACTION OF CARBON DIOXIDE WITH GRAPHITE. I. PRESSURE AND GEOMETRY EFFECTS. Copestake, T. B.; Corney, N. S. (General Electric Co. Ltd., Wembley, Eng.). pp 339-44 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

The radioinduced reaction of CO_2 with graphite was investigated in sealed silica bulbs irradiated in BEPO or in a gamma flux from a spent fuel-element source. Within a limited dose range, CO was the only product and the extent of its formation was proportional to the dose. The value of G(CO) was strongly dependent upon the CO_2 pressure and the geometry of the graphite specimen relative to the bulb. G(CO) did not appear to be influenced by pre-treatment of the graphite, although gaseous impurities, particularly mercury and water vapor, reduced the CO formation. The mechanism of the reaction appears to be one of energy absorption in the CO_2 producing active species which may undergo destruction in the gas phase in competition with diffusion to the graphite surface and reaction there to give CO. Two experimental conditions which were used emphasized the homogeneous destruction reaction when the gas was mainly exterior to the graphite pore structure, or the heterogeneous reaction when the gas was confined to the pores. (auth)

11816 RADIATION-INDUCED REACTION OF CARBON DIOXIDE WITH GRAPHITE. II. CONSIDERATION OF REACTION MECHANISM. Corney, N. S.; Jones, H. A. (General Electric Co. Ltd., Wembley, Eng.). pp 345-52 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

Possible reaction mechanisms of the radioinduced reaction of CO_2 with graphite were investigated on the basis that energy absorption in the CO_2 is responsible for the formation of an active species. This species may then diffuse to the graphite surface and react there, a process which is in competition with its recombination or deactivation in the gas phase. The active species

may be an oxygen atom and be destroyed in the gas phase by a two or three-body recombination with a CO molecule, or it may be an excited CO_2 molecule which is deactivated in the gas phase on collision with an ordinary CO_2 molecule. General expressions were derived for these mechanisms, and the experimental results were compared with the predictions from each mechanism, using the best available data for the appropriate rate constants. The predictions from each of the mechanisms showed a considerable amount of agreement with experimental results, but those from the oxygen-atom mechanisms showed somewhat better agreement than those based on the assumption that the active species is an excited CO_2 molecule. (auth)

11817 RADIATION-INDUCED REACTION OF CARBON DIOXIDE WITH GRAPHITE. III. IRRADIATION STUDIES OF THE GRAPHITE–CO–CO_2 SYSTEM. Cluley, H. J.; Corney, N. S. (General Electric Co. Ltd., Wembley, Eng.). pp 353-9 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

It was found by using the high sensitivity of the ^{14}C-labelling technique that the radiolysis of pure CO_2 is negligible at dose rates up to 5.5×10^{-5} eV (CO_2 molecule)$^{-1}$ sec^{-1}. In the irradiation of CO–CO_2 mixtures, however, deposits were formed, although no evidence has been obtained for the establishment of a condition of radiation stability in the gas phase. These deposits were nucleated in the gas phase and were subsequently detected on the walls of the vessel and in the pores of a graphite specimen. When a CO–CO_2 mixture was irradiated in the presence of graphite a condition of pseudo-equilibrium was set up when the rate of formation of CO by the graphite–CO_2 reaction was equal to the rate of loss of CO by radiolysis. A marked decrease in the value of G(–CO) was observed when the partial pressure of CO in a CO–CO_2 mixture was below a value of about 500 mm Hg. This effect was attributed to the reaction of CO_2 with intermediate species in the radiolytic decomposition of CO. (auth)

11818 REACTION OF CHLORINATED ETHYLENES WITH HYDRATED ELECTRONS AND OH-RADICALS IN AQUEOUS SOLUTION. Koester, R.; Asmus, K.-D. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch.; 26b: No. 11, 1108-16(Nov 1971). (In German).

The reactions of chlorinated ethylenes with hydrated electrons and OH radicals were investigated by using the method of pulse radiolysis. In addition γ experiments were carried out. The reduction of the solutes occurs via a dissociation electron capture process, the rate constant for the reaction of e^-_{aq} with the more chlorinated compounds is essentially diffusion controlled (k = 1 to 2×10^{10} l · mole^{-1} sec^{-1}). Vinyl chloride and 1,2-trans-dichloroethylene react more slowly. This can be related to the higher stability of the C–Cl bond in these compounds. Hydroxyl radicals add to the C=O double bond of the chlorinated ethylenes. The rate constant for the reaction with vinyl chloride was determined to 7.1×10^9 mole^{-1} sec^{-1}, and decreases with increasing degree of chlorination of the ethylenes. This effect is explained by the decreasing electron density on the C atoms and steric hinderance. The hydroxyl radical always adds to the C atom carrying the smallest number of C atoms. In its reaction with 1,2-dichloro-, trichloro-, and tetrachloroethylene a radical is produced with an OH group and a Cl atom on the same C atom. It eliminates HCl to form a C=O bond with k > 7×10^5 sec^{-1}. The radical produced in this reaction has an optical absorption in the near uv (ϵ_{265nm} = $(1-3) \times 10^3$ l · mole^{-1} cm^{-1}). The OH radical addition products of vinyl chloride and 1,1-dichloroethylene do not eliminate HCl and have no absorption in the visible and near uv. (auth)

11819 ELECTRON SPIN RESONANCE OF γ-IRRADIATED POLY(ETHYLENE 2,6-NAPHTHALENE DICARBOXYLATE). Rogowski, R. S.; Pezdirtz, G. F. (Langley Research Center, Hampton, Va.). J. Polym. Sci., Part A-2; 9: No. 12, 2111-17 (Dec 1971).

The two types of radicals trapped in γ-irradiated poly(ethylene 2,6-naphthalene dicarboxylate) (PEN 2,6) have been identified by ESR as –O–$\dot{C}$H–CH_2–O– (radical I) and a radical located on the naphthalene ring (radical II). The relative concentrations of radicals in the gross polymer are 10 to 20% radical I and 80 to 90% radical II. Similar trapped radicals have been identified in γ-irradiated poly(ethylene terephthalate) (PET), a structurally related polymer which differs only in the aromatic moiety, but the relative radical concentrations are quite different. These results are discussed in relation to the radiation resistance of the two polymers. (auth)

11820 FORMATION OF H-ATOMS FROM HYDRATED ELECTRONS. Cercek, B. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature (London) Phys. Sci.; 234: No. 51, 159-60(20 Dec 1971).

It has been shown that reaction of e^-_{aq} with $H_3O^+_{aq}$ yields H_3O radicals and not H-atoms, and it seemed feasible that H_3O radicals could decay to yield H-atoms. If this is so the reactivity of the species produced by the reaction $e^-_{aq} + H_3O^+_{aq}$ should be a function of the solute concentration, and to test this hypothesis the effect of nitrobenzene concentration on the second order rate constant for the formation of nitrocyclohexadienyl radicals from species produced by the reaction of e^-_{aq} was studied. Electron pulse radiolysis was used to measure the rate of formation of the dienyl radicals, and methanol was used to scavenge OH radicals. The results strongly supported the hypothesis that H_3O radicals decay to yield H-atoms. A reaction scheme and differential equations are presented for formation of the dienyl radicals. (UK)

11821 PULSE RADIOLYSIS STUDIES ON REACTIVE INTERMEDIATES IN ORGANIC CHEMICAL PROCESSES. Adams, G. E.; Willson, R. L. (Mount Vernon Hospital, Northwood, Eng.). Annu. Rep. Progr. Chem., Sect. B; 67: 207-18(1970).

Application of the pulse radiolysis technique to the study of short-lived organic intermediates continues. Interest has been maintained in organic free-radical equilibria, reactions of hydrated electrons, hydrogen atoms, and hydroxyl radicals in aqueous organic media, general properties of organic radicals, and in effects of molecular structure. There has been a notable increase in interest in the study of short-lived intermediates in biochemical and biological processes. These include reduction and oxidation processes in amino acids, simple peptides, enzymes, and the nucleic acids, mechanisms of protein binding, free-radical mechanisms in cellular radiosensitisation, and various examples of biochemically related electron-transport systems. Some early results have been published on the application of the picosecond pulse radiolysis technique showing that free electrons in both water and alcohols become solvated in times less than 10^{-11} s. However, in the presence of high concentrations of acceptors, such as acetone, electron capture can occur earlier, before solvation. The detection and recording of transient spectra by self-absorption of Cherenkov light produced during nanosecond pulse radiolysis is reported. Some spectra of solvated electrons and also a benzene excimer have been confirmed. (UK)

11822 PHOTOLYSIS AND RADIOLYSIS OF SIMPLE MERCAPTANS IN DILUTE GLASSY MATRICES. Skelton, J.; Adam, F. C. (Univ. of Calgary, Alberta). Can. J. Chem.; 49: No. 21, 3536-43(1 Nov 1971).

The EPR spectrum of thiyl radicals is obtained when dilute solutions of aliphatic mercaptans are photolyzed in a xenon matrix at 77°K. No proton hyperfine structure was observed at low concentrations of thiol but it appears at higher concentrations due to the reaction of hot hydrogen atoms with solute mercaptan molecules. When small amounts of the thiols are dissolved in glassy hydrocarbon matrices such as 3-methylpentane, there is produced after photolysis hyperfine structure characteristic of the solvent as well as the thiyl resonance. The ESR absorption due to the solvent species disappears when the matrix is warmed a few degrees above 77°K but thiyl radicals are stable up to the melting point of the glass. The corresponding γ-irradiated glasses do not give thiyl absorption, but two other species are produced along with solvent radicals. No thiyl radicals are observed following radiolysis, or upon photobleaching the new species. The spatial distribution of the neutral radicals in the glasses is discussed in view of these results. (auth) (Canada)

11823 RADIOLYSIS OF TRIFLUOROACETIC ACID. Betts, J.; Cherniak, E. A. (Carleton Univ., Ottawa). Can. J. Chem.; 49: 3389-93(15 Oct 1971).

The gaseous products of the ^{60}Co γ radiolysis of liquid CF_3COOH at 23°C and solid CF_3COOH at –196°C were identified and their G-values were determined. The products and G-values are, for the radiolysis of liquid CF_3COOH; CO_2(7.1), CO(0.71), CF_3H(0.27), C_2F_6(1.36), H_2(0.031) and, for the radiolysis of solid CF_3COOH; CO_2(2.5), CF_3H(0.30), C_2F_6(0.39). CO and H_2 were not produced in the radiolysis of solid CF_3COOH and CF_4 and C_2F_4 were not produced in the radiolysis of solid and liquid CF_3COOH. The mechanisms of gaseous product formation in the radiolysis of solid and liquid CF_3COOH are compared. (auth) (Canada)

11824 PULSE RADIOLYSIS OF FORMAMIDE AND FORMAMIDE–WATER MIXTURES. Walker, D. C.; Wallace, S. C. (Univ. of British Columbia, Vancouver). Can. J. Chem.; 49: 3398-3401(15 Oct 1971).

From the optical absorption spectrum observed by a sub-nanosecond pulse radiolysis method it is concluded that irra-

diated pure liquid formamide (dielectric constant = 109) does not yield solvated electrons with lifetimes $>10^{-11}$ s. In formamide–water mixtures the hydrated electron was formed in low yield and the position of the absorption band of e^-_{aq} was not altered by changing the composition. Apparently formamide reacts much more rapidly with thermalized electrons than it does with hydrated electrons. The latter may be formed in formamide–water mixtures due to aggregates of water molecules. (auth) (Canada)

11825 ION SCAVENGING BY NEOPENTANE IN γ-IRRADIATED LIQUID ALKANES. Stone, J. A.; Matsushita, G. (Queen's Univ., Kingston, Ont.). Can. J. Chem.; 49: 3287-91 (15 Oct 1971).

The γ radiolysis of low concentrations of neopentane in liquid cyclo-C_5H_{10} and C_2H_6 at 0.25 g ml^{-1} density leads to methane yields much greater than expected from the mixture compositions. In cyclo-C_6H_{12}, n-C_6H_{14}, cyclo-$C_6H_{11}CH_3$, and 3-methylpentane the yields are much less than expected. The effect is explained in terms of positive ion scavenging which is enhanced by added electron scavengers. The efficiency of scavenging by $C(CD_3)_4$ in C_2H_6 is equal to that of ND_3. The efficiency in cyclo-C_5H_{10} is less than that in C_2H_6 but is greater than that observed previously in this solvent. (auth) (Canada)

Radioisotope Production

Refer also to abstracts 11856, 11866, 11880, 11884, and 13914.

11826 (ORNL–4718) TRANSURANIUM PROCESSING PLANT SEMIANNUAL REPORT OF PRODUCTION, STATUS, AND PLANS FOR PERIOD ENDING JUNE 30, 1971. Burch, W. D.; Bigelow, J. E.; King, L. J. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 35p. Dep. NTIS.

During the period January 1, 1971, through June 30, 1971, 330 g of ^{244}Cm, 18 mg of ^{249}Bk, 131 mg of ^{252}Cf, and 79 μg of ^{253}Es were recovered as purified products from 129 reactor slugs irradiated as part of the Californium-I program at the Savannah River Plant (SRP) to evaluate the commercial market for ^{252}Cf and establish an inventory of ^{252}Cf for sale. In addition, 9.9 g of ^{242}Pu, 4 g of ^{243}Am, 40.2 g of ^{244}Cm, 6.1 mg of ^{249}Bk, 62 mg of ^{252}Cf, 379 μg of ^{253}Es, and 9×10^8 atoms of ^{257}Fm were recovered from 18 irradiated HFIR targets. A proposal was made to irradiate 200 g of curium for the Californium-I program. The processes and equipment used for the SRP reactor slugs were generally the same as those used to process HFIR targets. The curium products met all of the Savannah River Laboratory specifications. Satisfactory operation of the continuous Tramex solvent extraction equipment could not be established and batch Tramex extractions had to be used. Catastrophic pitting-type corrosion of a vacuum transfer system was observed as the result of its contact with HCl dissolver solutions. Tests were made using prototypes of the standard TRU neutron source capsules, and the results were forwarded to the AEC Division of Materials Licensing for cataloging. Seven neutron sources were fabricated during this period. Equipment for assaying californium sources and shipping packages by means of fast-neutron counting was installed in the source and target decontamination facility. Results of comprehensive tests showed the system to be excellent (reproducible within ±1%) for comparing sources and shipping packages with a standard source that is assayed within the same test period. Two rabbits containing isotopically pure ^{253}Es were fabricated, irradiated, and delivered for use in studying the energy-level structure of ^{250}Bk. Also, a gamma source was fabricated from 1 g of ^{242}Pu for use in Moessbauer studies. The values currently being used for transuranium element decay data and for cross section data in planning irradiation-processing cycles, calculating production forecasts, and assaying products are tabulated in the Appendix. (auth)

11827 (STI/DOC–10/128) RADIOISOTOPE PRODUCTION AND QUALITY CONTROL. (International Atomic Energy Agency, Vienna (Austria)). 1971. 968p. IAEA $25.00.

A manual on isotope production is presented. An abstract was prepared for each of the seven sections. (D.H.M.)

For abstracts of individual sections see: 11832–11835, 11977, 12022, and 12378.

11828 PRODUCTION OF ^{85}Sr WITHOUT A CARRIER. Mikheev, N. B.; Savel'ev, G. I.; Popovich, V. B. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 323-5(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 312-14(Mar-Apr 1971).

^{85}Sr can be produced in the radioisotopically pure state and without a carrier by irradiation of rubidium on a cyclotron by one of the following reactions: $^{85}Rb(d,2n)^{85}Sr$ or $^{85}Rb(p,n)^{85}Sr$. Microquantities of strontium could be separated from macroquantities of rubidium by adsorption of strontium on activated charcoal. Practically complete elution of ^{85}Sr from the charcoal column could be achieved with 0.2 N HCl. (M.C.G.)

11829 ISOLATION OF ^{55}Fe FROM NICKEL IRRADIATED ON A CYCLOTRON. Kuzin, I. A.; Kuznetsov, N. P.; Bernotas, V. I.; Tsvetkov, V. S.; Chetvergov, E. G. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 334-6(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 320-2(Mar-Apr 1971).

A method was developed for the separation of radioquantities of iron from macroquantities of nickel and radioquantities of cobalt, based on the ability of a highly selective cation exchanger, oxidized charcoal, to absorb multiply charged cations especially well. This method was used for the isolation of radioisotopically pure ^{55}Fe from a nickel target irradiated on a cyclotron. The radioactive isotope of iron, ^{55}Fe, was identified according to a calibrated source obtained from the physics laboratory of the International Atomic Energy Agency; its radioisotopic and radiochemical purity was investigated. The coefficient of purification of ^{55}Fe from nickel is no less than 10^6. (auth)

11830 ISOLATION OF $^{83,84}Rb$ FROM SODIUM BROMIDE IRRADIATED WITH α PARTICLES ON A CYCLOTRON. Kuznetsov, N. P.; Kuzin, I. A.; Bernotas, V. I.; Tsvetkov, V. S.; Kaufman, V. Z. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 337-9(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 323-4(Mar-Apr 1971).

A method was developed for the separation of radioquantities of rubidium from macroquantities of sodium on oxidized SKT charcoal. This method was used to isolate $^{83,84}Rb$ from sodium bromide irradiated with α particles. Identical results were obtained on the phenol formaldehyde sulfocation exchange resin KU-1. The radioisotopic purity of the isolated $^{83,84}Rb$ was investigated. (auth)

11831 GRAM-SCALE PURIFICATION OF ^{244}Cm BY EXTRACTION CHROMATOGRAPHY. Buijs, K.; Maino, F.; Mueller, W.; Reul, J.; Toussaint, Cl. (Euratom, Inst. for Transuranium Elements, Karlsruhe, Ger.). Angew. Chem. Int. Ed. Engl.; 10: No. 10, 727-8(Oct 1971).

An oxide mixture containing 5.9 g of ^{244}Cm and 5.1 g of ^{243}Am formed the starting material for preparation of high-purity curium oxide. A preliminary Am–Cm separation by two successive precipitations of $K_2AmO_2(CO_3)_2$ yielded a Cm fraction containing 2.7% of Am and an Am fraction containing 0.4% of Cm. The Cm fraction was then purified further by extraction chromatography and cation exchange. A flowsheet is shown. The purification procedure reduced the inactive impurity content in the Cm from 7.8 to 0.65%; the residual Am content was 0.28%. (M.C.G.)

11832 REACTOR-PRODUCED ISOTOPES. pp 63-542 of Radioisotope Production and Quality Control. Vienna; International Atomic Energy Agency (1971).

See STI/DOC–10/128.

The production of radioisotopes by reactor irradiation is reviewed and procedures are described for the production of ^{82}Br, ^{45}Ca, ^{38}Cl, ^{51}Cr, ^{58}Co, ^{64}Cu, ^{198}Au, ^{125}I, ^{131}I, ^{59}Fe, ^{140}La, ^{54}Mn, ^{197}Hg, ^{203}Hg, ^{32}P, ^{42}K, ^{86}Rb, ^{111}Ag, ^{24}Na, ^{35}S, ^{90}Y, and ^{65}Zn. (D.H.M.)

11833 SPECIAL TECHNIQUES. pp 543-655 of Radioisotope Production and Quality Control. Vienna; International Atomic Energy Agency (1971).

See STI/DOC–10/128.

Special techniques considered include production of sealed radioisotopic radiation sources; production of isotopes by secondary nuclear reactions; description of procedures for secondary nuclear reactions for production of ^{7}Be, ^{18}F, and ^{28}Mg; Szilard–Chalmers processes for isotope production; and description of procedures for Szilard–Chalmers processes for production of ^{51}Cr, ^{64}Cu, ^{59}Fe, and ^{32}P. (D.H.M.)

11834 RADIOISOTOPES DERIVED FROM GENERATORS. pp 657-743 of Radioisotope Production and Quality Control. Vienna; International Atomic Energy Agency (1971).

See STI/DOC–10/128.

A review of radioisotope generators is presented that includes principles, applications, possible generators, choice of ideal generators, chromatographic columns, commonly used generators, commercial presentation, chemical and biological controls, and kits. Procedures are described for $^{113}Sn–^{113m}In$, $^{115}Cd–^{115m}In$, $^{87}Y–^{87m}Sr$, and $^{99}Mo–^{99m}Tc$ generators and procedures for preparations incorporating generator-produced radioisotopes are also given. (D.H.M.)

11835 ACCELERATOR-PRODUCED RADIOISOTOPES. pp 745-820 of Radioisotope Production and Quality Control. Vienna; International Atomic Energy Agency (1971).

See STI/DOC-10/128.

A review on the use of accelerators for the production of radioisotopes is presented. Procedures for the accelerator-production of ^{7}Be, ^{206}Bi, ^{132}Cs, ^{18}F, ^{123}I, ^{28}Mg, ^{52}Mn, and ^{85}Sr are described. (D.H.M.)

11836 ADAPTATIONS OF A PHYSICS DEPARTMENT CYCLOTRON FOR GENERATING RADIONUCLIDES FOR BIOMEDICAL APPLICATIONS. Myers, W. G. (Ohio State Univ., Columbus). 6p of Symposium on the Use of Cyclotrons in Medicine. London; Medical Research Council (1969).

From Symposium on the use of cyclotrons in medicine; London, England (20 Sep 1969). See CONF-690979.

The following work at the Physics Dept. cyclotron at Ohio State Univ. is briefly reviewed: heat dissipation, melting and vaporization of targets, target metaborates, and generation of 20 minute ^{11}C, 1.83 hour ^{18}F, 13.0 hour ^{123}I, and 2.1 hour ^{121}I. The machine provides internal beams of up to 50 microamperes of 6.5-MeV protons or 13-MeV deuterons. Also, 5 to 10 μA beams of 24-MeV ^{4}He ions are available and similar currents of 18-MeV ^{3}He ions since the addition of a ^{3}He recovery system. Twelve nuclear reactions used are listed. Up to millicurie quantities of ^{24}Na, ^{32}P, ^{42}K, ^{87}Y, ^{121}I and ^{123}I have been generated as well as multimillicurie amounts of ^{11}C and ^{18}F. (UK)

11837 RECENT WORK WITH THE SLOAN-KETTERING INSTITUTE CYCLOTRON FOR RADIONUCLIDE PRODUCTION. Tilbury, R. S.; Mamacos, J. P.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research, New York). 7p of Symposium on the Use of Cyclotrons in Medicine. London; Medical Research Council (1969).

From Symposium on the use of cyclotrons in medicine; London, England (20 Sep 1969). See CONF-690979.

Since December, 1967, eight radionuclides have been produced with the Sloan–Kettering cyclotron. Fluorine-18 is produced once a week in 75-mCi amounts using 23-MeV helium-3 particles on water. The chemical form of the ^{18}F in the raw product solution was shown to be the fluoride ion and not complex metal fluoride. Iron-52 is produced in amounts up to 1 mCi using helium-3 particles on electroplated chromium targets using the internal probe. A separation procedure using ion exchange requires the addition of no iron carrier and gives a chemical recovery of 90%. The iron-52 content of the iron-52 product was found to be 0.3% for a four-hour bombardment. A system was constructed for the preparation of radioactive gases O_2, CO, CO_2, and N_2 labelled with ^{15}O, ^{11}C and ^{13}N. The yield of $^{13}N_2$ was increased ten fold by using 15-MeV protons compared with 8-MeV deuterons on carbon. The production of iodine-123 and iodine-121 was studied using helium-3 on enriched isotopes of antimony and tellurium (122 and 123). Chromium-48 was prepared in yields of 10 $\mu Ci/\mu Ah$ by irradiating titanium with He-3 particles. Chromium-51 was produced as 3.5% at the end of irradiation. An attempt was made to prepare some ^{11}C-labelled organic compounds by direct irradiation of the organic compound followed by a rapid chemical purification and separation using high pressure column chromatography. Compounds which were studied in this way are toluidine-blue, thymidine and tryptophane. (auth) (UK)

Recoil Production and Reactions

Refer also to abstracts 11851, 11855, and 11860.

11838 OPENING OF THE RING OF CYCLOHEXANE BY TRITIUM RECOIL ATOMS. Avdonia, E. N. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 258-60(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 259-63(Mar-Apr 1971).

The yields of labeled products from cleavage of the cyclohexane ring, formed by tritium recoil atoms in liquid and solid mixtures of cyclohexane with benzene, were measured. It was suggested that unsaturated labeled products are formed during molecular decomposition of a cyclohexane molecule excited by replacement of H by T, a process that occurs more effectively in liquid media than solid media. The formation of labeled saturated C_1-C_6 products occurs by cleavage of a C–C bond by a tritium atom with the formation of an excited labeled hexyl radical. The yield of this process is proportional to the cyclohexane concentration in the mixture and does not depend on the phase state. The excited hexyl radical either strips hydrogen from the cyclohexane molecules, giving labeled n-hexane, or decomposes, forming lighter labeled radicals, which also react to form the corresponding alkanes. The probability of decomposition of the hexyl radical, and, consequently, the formation of labeled light alkanes is greatly reduced in solid systems as compared with liquid systems. (auth)

11839 CHEMISTRY OF NUCLEAR RECOIL ^{18}F ATOMS. V. MECHANISM AND SYSTEMATICS IN CH_3CF_3. Krohn, Kenneth A.; Parks, Norris J.; Root, John W. (Univ. of California, Davis). J. Chem. Phys.; 55: No. 12, 5771-84(15 Dec 1971).

Nuclear recoil ^{18}F atoms undergo hot F-for-F and F-for-H atomic substitution and hot F-for-CH_3 and F-for-CF_3 alkyl replacement reactions in CH_3CF_3. The primary absolute yields corresponding to these processes are 3.56 ± 0.07, 8.22 ± 0.09, 5.79 ± 0.31, and 8.5 ± 2.5% (estimated value), respectively. The total primary hot yield for organic products is 26.1 ± 2.5%, and that for all hot reactions including F-to-HF and F-to-F_2 abstraction is 83 ± 3%. There is no evidence in favor of hot F-for-2F or F-for-2H double substitution reactions in CH_3CF_3. Recoil ^{18}F exhibits approximately a sixfold systematics preference for alkyl replacement reactions at the carbon–carbon bond in CH_3CF_3 relative to the average of substitution reactivities at carbon–fluorine and carbon–hydrogen bonds. The per-bond preference for primary substitution reactions at carbon–hydrogen relative to carbon–fluorine bonds is 2.30 ± 0.06. The sums of primary hot yields for organic products are comparable for recoil ^{18}F in CH_3CF_3 vs recoil ^{3}H in alkanes, so that these two recoil systems differ principally in that ^{18}F exhibits a preference for alkyl replacement reactions, whereas recoil ^{3}H exhibits a preference for T-for-H substitution. All the organic products from primary ^{18}F hot reactions exhibit extensive unimolecular decomposition. (auth)

11840 CHEMISTRY OF NUCLEAR RECOIL ^{18}F ATOMS. VI. APPROXIMATE ENERGETICS AND MOLECULAR DYNAMICS IN CH_3CF_3. Krohn, Kenneth A.; Parks, Norris J.; Root, John W. (Univ. of California, Davis). J. Chem. Phys.; 55: No. 12, 5785-94(15 Dec 1971).

Energetics and molecular dynamics results are reported from an extensive set of high-energy recoil ^{18}F experiments with CH_3CF_3. Based on thermochemical evidence alone, substantial fractions of the primary hot F-for-H, F-for-CH_3, and F-for-CF_3 reaction products are indicated to involve minimum excitation energies of 7.9 ± 0.2, 9.3 ± 0.1, and 3.5 ± 0.2 eV, respectively. The primary F-for-F reaction products in CH_3CF_3 do not exhibit unimolecular decomposition via a carbon–carbon bond scission mode in apparent violation of RRKM theoretical predictions. The primary F-for-H products decompose both via β elimination of HF and via carbon–carbon bond scission in apparent accord with theory. More than one kind of microscopic dynamics is involved in the primary hot F-for-H and F-for-CH_3 processes in CH_3CF_3 and in the primary hot F-for-F process in CF_4. Direct, concerted, and collusive dynamics are required for the higher energy reaction modes for these processes. (auth)

11841 REACTIONS OF RECOIL PRODUCTS FROM A ^{224}Ra SOURCE WITH ALKYL RADICALS. Hoffmann, P.; Baechmann, K.; Boegl, W.; Klenk, H.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta; 16: No. 3-4, 172-9(Dec 1971). (In German).

The formation of alkyl compounds by recoil products of ^{224}Ra (^{212}Pb, ^{212}Bi, ^{208}Tl) are reported. The compounds are formed in the gaseous phase with alkyl radicals obtained by thermal decomposition of lead tetraalkyls. The chemical yields obtained are between 60 and 90% for ^{212}Pb, 90 to 190% for ^{212}Bi, and 40 to 85% for ^{208}Tl. The yields refer to the nuclides, whose quantity was determined separately, which get into the gaseous phase through recoil processes. For comparison, a number of experiments with helium, hydrogen, nitrogen, argon, acetone, diethyl ketone, and undecomposed lead tetraalkyls have been performed in all of which a transfer of ^{220}Rn was found. (auth)

11842 RADIOCHEMICAL REACTIONS OF FERROCENE IN $Fe(CO)_5$ SOLUTION. Kanellakopulos-Drossopulos, W.; Wiles, D. R. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta; 16: No. 3-4, 179-82(Dec 1971).

Yields of $^{59}FeCp_2$ were determined following neutron irradiation of the mixed systems: $FeCp_2$–$Fe(CO)_5$–C_6H_6, using both normal $FeCp_2$ and $FeCp_2$ depleted in ^{58}Fe. The results show for liquid solutions that the normal $FeCp_2$ produced only about 30% more $^{59}FeCp_2$ than the depleted target. This is taken to mean that the recoil-produced iron atoms may come from other molecules in the solution to form radioactive $FeCp_2$ after a short trajectory or diffusion path. In frozen targets normal $FeCp_2$ gave a 11% yield of $^{59}FeCp_2$ while depleted $FeCp_2$ yielded 0.5%. This is interpreted as suggesting that the $FeCp_2$ may be present in the solid in micro crystalline form. Formation of ferrocene molecules by nuclear reaction is clearly not dependent on preservation of former bonding configurations. (auth)

11843 EFFECT OF BENZENE ON THE REACTION OF THE RECOIL BROMINE ATOM WITH ETHYL BROMIDE. Shiokawa,

Takanobu; Sato, Toshiro; Kondo, Kenjiro (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 44: No. 7, 1746-50(Jul 1971).

An attempt was made to estimate the effect of benzene on the recombination reactions of the recoil bromine atoms activated by the $^{81}Br(n,\gamma)^{82m}Br \xrightarrow{IT} {}^{82}Br$ and $^{81}Br(n,2n)^{80m}Br$ reactions in ethyl bromide and benzene mixtures. It seems to be reasonable to conclude, from the consideration of the parent yield, that the reactions leading to the formation of parent molecules in the thermal and high-energy regions can be classified into two reaction types. Judging from the results of the $^{81}Br(n,\gamma)^{82m}Br \xrightarrow{IT} {}^{82}Br$ reaction, approximately 53% of the parent yield from the high-energy reactions in the pure ethyl bromide system is formed through the de-excitation process of the excited ethyl bromide labeled by the direct substitution reaction of the energetic recoil atom, while 47% is formed by the reaction of the recoil atom with ethyl radicals in the cage. The reaction of ethylene with hydrogen bromide, which is produced by the decomposition of the labeled excited ethyl bromide, contributes about 51% of the parent yield from the thermal energy reaction; the rest is formed by the other thermal reactions. Furthermore, no essential difference was observed between the recombination reactions of the recoil ^{82}Br and ^{80m}Br atoms produced by the $^{81}Br(n,\gamma)^{82m}Br \xrightarrow{IT} {}^{82}Br$ and $^{81}Br(n,2n)^{80m}Br$ reactions respectively. (auth)

11844 PRODUCTION OF ^{13}N LABELED AMMONIA FOR MEDICAL USE. Tilbury, R. S.; Dahl, J. R.; Monahan, W. G.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research, New York). Contract AT(30-1)-910. Radiochem. Radioanal. Lett.; 8: No. 6, 317-23(31 Dec 1971).

A method is described for the production of ^{13}N-labeled ammonia for medical use by irradiating methane gas with 7.5-MeV deuterons. The methane is flowed through a glass target chamber into a bubbler containing isotonic saline solution. 60 mCi of ^{13}N-labeled ammonia in 7 ml saline for injection were prepared in this way. (auth)

11845 RADIOGAS CHROMATOGRAPHIC SEPARATION OF ^{82}Br RECOIL PRODUCTS FROM THE IRRADIATED MIXTURES OF BROMINE AND CHLOROFLUOROMETHANES. Tominaga, Takeshi; Makide, Yoshihiro; Okada, Shigeharu; Kunimasa, Yasushi; Wada, Kazuo (Tokyo Univ.). Radioisotopes (Tokyo): 20: No. 10, 541-2(Oct 1971).

^{82}Br-labeled recoil products from neutron-irradiated mixtures of bromine and chlorofluoromethanes (CF_2Cl_2 and $CFCl_3$) or CF_3Br were separated by radiogas chromatography. Preliminary results indicated that the yields of products mainly derived from ^{82}Br-for-Cl substitution (about 2 to 5%) are larger than those of the products mainly derived from ^{82}Br-for-F substitution (about 0 to 0.5%). (M.C.G.)

11846 CHEMICAL STATES OF RADIOACTIVE ANTIMONY AND TELLURIUM FORMED UPON HIGH-ENERGY PROTON IRRADIATION OF CESIUM HALIDES. Dema, I. (Inst. of Atomic Physics, Bucharest); Zaitseva, N. Radiochem. Radioanal. Lett.; 8: No. 6, 325-32(31 Dec 1971).

The chemical states of radioactive nuclides of tellurium and antimony formed upon proton irradiation of crystal-line cesium chloride and cesium bromide were determined. At room temperature large yields of reduced forms were obtained. By thermal annealing of irradiated crystals at 100°, 200°, 340°, and 425°C, oxidation and reduction processes were evidenced. On comparing the fate of Sb, Te, and I recoils from a cesium chloride matrix, a different behavior is observed. (auth)

11847 REACTIONS OF HOT HYDROGEN ATOMS, AND RADIATION-CHEMICAL REACTIONS IN n-NONANE. Kukin, P. P.; Vandlik, Ya.; Filatov, E. S. (Moscow State Univ.). This paper was summarized in Khim. Vys. Energ.; 3: No. 5, 445-6 (Sep-Oct 1969). (In Russian).

Full copy of this paper is held by DTIE.

A comparative investigation was made of radiation-chemical reactions, and of the reactions of hot hydrogen atoms with organic compounds at 70°C, using n-nonane as the example. The tritium atoms required were obtained from the nuclear reaction $^6Li(n,\alpha)T$. The absorbed dose amounted to 6×10^{21} eV/g. Analysis of the products was carried out using a "Tsvet" chromatograph, using a flow proportional counter to record the β radiation of tritium. In the presence of 4×10^{-2} mole/liter of iodine, the yields of alkanes were reduced, and there was practically no change in the yields of alkenes. The ratio HT/H_2 was independent of the presence of iodine, while that of CH_3/CH_4 increased by a factor of ~1.5 for an iodine concentration of 5×10^{-2} mole/liter. Tritium-containing alkenes were formed to a smaller extent than the alkanes. The formation of tritium-containing hydrocarbons cannot be explained by radiation-chemical reactions (since the specific activity of the hydrocarbons, i.e., the ratio $C_nH_{2n+1}T/C_nH_{2n+2}$ exceeds by a factor of ~50 the specific activity of n-nonane, which would not be the case if the labeled hydrocarbons were obtained only by radiolysis; on the other hand, the radiation-decomposition of n-nonane amounted to ~2%, while the yield of labeled hydrocarbons as a whole exceeded 45% of the yield of n-nonane, which appears to be the result of specific hot processes that would lead to the statistical distribution of the labeled alkanes). During the reactions of hot atoms, direct replacement of alkyl groups takes place, with the formation of tritium-containing alkanes. The reactions take place by a route that involves the rupture of the C—C bond, followed by a rapid, noninhibited, process, involving recombination of tritium with the radicals. In this case the yield of tritium-containing alkanes should be uniform, which was actually the case for hydrocarbons in the range C_2-C_7. An "end" effect was found, involving increased yield of CH_3T, and reduced yield of $C_9H_{17}T$. The similarity found in the distribution of tritium among the alkanes and the relative radiation yields may be explained by the fact that the decomposition of the hydrocarbons induced by irradiation results in the formation of hot radicals, which are stabilized in the form of alkanes as a result of the splitting off of hydrogen. (auth)

11848 BROMINE ISOMERS UNDER (n,γ) PROCESS. Lal, A. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 6: No. 9, 481-3(Sep 1968).

The uncertainty regarding higher collection of active bromine on the electrodes was studied with ethyl bromide and a possible explanation of the preferential collection is attempted on the basis of Auger electron hypothesis suggested by P. R. Geissler and J. E. Willard [J. Phys. Chem., 67: (1963), 1675]. The relative yields of ^{80}Br and ^{80m}Br following thermal neutron irradiation of $C_2H_4Br_2$, C_2H_5Br, and C_6H_5Br for varying durations of time (3 to 22 hr) with and without electric field applied across the collecting electrodes were determined. It is observed that the ratio ^{80}Br to ^{80m}Br first decreases and then increases with an increase in the neutron irradiation time in the absence of an electric field across the collecting electrodes. This ratio is markedly influenced by an electric potential applied across the electrodes. It is found to be higher in the case of aromatic compounds than in the case of the aliphatic ones. (auth)

11849 HOT-ATOM CHEMISTRY OF ^{60}Co ATOMS IN NEUTRON IRRADIATED ORGANIC SOLUTIONS OF TRIS(ACETYLACETONATO)COBALT(III). Tominaga, Takeshi; Sakai, Takuhiko, Fujiwara, Kitao (Tokyo Univ.). Bull. Chem. Soc. Jap.; 44: No. 11, 3036-9(Nov 1971).

Thermal neutron irradiation has been carried out on the solutions of tris(acetylacetonato)cobalt(III) in benzene, ethanol, acetone, and acetic acid containing various additives such as metallic salts and mineral acids. The ^{60}Co retention in the irradiation solutions has been found to decrease sharply with the increase in the concentration of various metallic salts. This indicates that the thermal diffusive reactions which contribute greatly to the apparent retention in the irradiated solutions can be suppressed by the addition of adequate metallic salts as scavengers. Salts of the metals which can form more stable complexes with acetylacetone (i.e., Fe(III), Cu(II), Al(III), etc.) work as more effective scavengers in these systems. The upper limit for the primary retention of tris(acetylacetonato)cobalt(III) in the benzene solutions has been estimated as 0.00 ± 0.02%. The use of adequate scavengers appears to be a useful technique to determine the primary retention in the irradiated solution systems. The ^{60}Co retention of the solid complex irradiated at dry ice temperature was 1.4 to 1.5% irrespective of the organic solvents used for dissolution if they contain ferric chloride, while it increased to 2.0% in the absence of the scavenger. (auth)

11850 ABIOLOGICAL SYNTHESIS OF ADENOSINE DI- AND TRIPHOSPHATES USING RECOILED ^{31}P ATOMS OBTAINED FROM THE β-DECAY OF ^{31}Si. Akaboshi, Mitsuhiko; Kawai, Kenichi (Kyoto Univ., Osaka, Japan). Biochim. Biophys. Acta; 246: No. 2, 194-6(Aug 1971).

Thirty mg of ^{30}Si (70 to 90% enriched $^{30}SiO_2$) were irradiated in the hydraulic conveyer of the KUR (Kyoto University Reactor) for 10 hr (thermal neutron flux, ~8.0×10^{13} neutrons/cm^2/sec). Immediately after the irradiation, 0.5 μCi of [^{14}C]AMP or [^{14}C]ADP was added, and all the ^{31}Si was allowed to decay 2 to 3 days at 0 to 3°C. Paper chromatography and radioautography showed that about 0.2% AMP and ADP was converted into ADP and ATP, respectively. The origin of optical activity in biological materials is discussed in connection with the nonconservation of parity during β decay. (auth)

Radiochemistry

Refer also to abstracts 11563, 11645, 11664, 11837, 11844, 11848, 11850, 11862, 11867, and 11872–11874.

11851 (FRNC-TH-123) STUDY OF THE CHEMICAL EFFECTS OF NEUTRON CAPTURE IN SOME SOLID NEUTRAL HAFNIUM CHELATES USING RADIOCHEMISTRY AND PERTURBED ANGULAR CORRELATIONS. Vulliet, Paul (Grenoble Univ. (France). Faculte des Sciences). 1970. 97p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A Szilard–Chalmers reaction was established for two chelates, $(BPHA)_4Hf$ and $(Cup)_4Hf$, as well as an isotopic effect between ^{180}Hf and ^{181}Hf, the latter being interpreted in terms of the energy difference between the mean recoil energies of each isotope. The structure and mass of the chelates strongly affect the retention. The annealed isochrones exhibit various reactions that may correspond to either recombination of the recoil fragments or oxidation-reduction phenomena enabling a change of activity in the radioactive nucleus. Attention is drawn to the importance of the role of defects in the annealing process. The results obtained using the method of perturbed $\gamma-\gamma$ angular correlations are comparable with those obtained using the radiochemical method. (France)

11852 SYNTHESIS OF THIAMINE-^3H BY $^6Li(n,\alpha)^3H$ NUCLEAR REACTION. Hayashi, Nobuyoshi (Takeda Chemical Industries, Ltd., Osaka). Takeda Kenkyusho-Ho; 30: No. 1, 22-4(Mar 1971). (In Japanese).

2-Methyl-4-amino-5-aminomethylpyrimidine was labeled with ^3H by the $^6Li(n,\alpha)^3H$ nuclear reaction in an atomic pile. The labile tritium was removed by an exchange reaction with the solvent. Thiamine-^3H hydrochloride was prepared from 2-methyl-4-amino-5-aminomethylpyrimidine-^3H. (auth) (Japan)

11853 METHOD OF INVESTIGATING THE SORPTION OF RADIOELEMENTS. Sheidina, L. D.; Rozovskaya, N. G.; Kovarskaya, E. N. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 183-6(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 180-4(Mar-Apr 1971).

In the investigation of the sorption of radioelements to study their state in solution, the only method usable is sorption from exposed solutions. An experimental verification established a cause of the contradictions in the data obtained by different authors in the study of the sorption of Pu(IV) under different experimental conditions. (auth)

11854 MOESSBAUER STUDIES OF THE OXIDATION STATE OF ^{57}Fe PRODUCED IN EC-DECAY OF ^{57}Co-DOPED AND IN γ-IRRADIATION OF ^{57}Fe-DOPED $Mn(acac)_3$, $Fe(acac)_2$, AND $Co(acac)_3$. Sano, Hirotoshi; Iwagami, Hiroko (Ochanomizu Univ., Tokyo). J. Chem. Soc., D; No. 24, 1637-8(22 Dec 1971).

It was demonstrated that the surrounding matrix of an EC-decayed $^{57}Co(acac)_3$ moiety is involved in the localized radiolytic process initiated by the Auger effect. (auth)

11855 CATION EXCHANGE SEPARATION OF ^{51}Cr-LABELLED SPECIES IN AQUEOUS Cr(VI)–Cr(III) SOLUTION. Collins, C. H.; Collins, K. E.; Ackerhalt, R. E. (State Univ. of New York, Buffalo. Western New York Nuclear Research Center, Buffalo). J. Radioanal. Chem.; 8: No. 2, 263-7(Aug 1971).

A convenient and precise separation procedure for aqueous $^{51}Cr(VI)$, $^{51}Cr(III)$-monomer, $^{51}Cr(III)$-polymer species, using a cation exchange resin, is described. Standard deviations of 0.3% for each component may be routinely obtained. (auth)

11856 WHAT WERE THE TRANSURANIUM ELEMENTS OF THE THIRTIES ACTUALLY? Menke, H.; Herrmann, G. (Univ., Mainz). Radiochim. Acta; 16: No. 3-4, 119-23(Dec 1971). (In German).

The β activities, which were obtained in the thirties by irradiation of uranium with slow neutrons and which were believed to be transuranium elements, consisted of at least 22 fission products. The main components of this mixture make understandable the chemical behavior of these "transuranium elements" in the separations performed at that time to show their chemical identity. (auth)

11857 TRITIUM DECAY SYNTHESIS OF FREE RADICALS. AN EPR STUDY OF 2-NAPHTHYL RADICAL IN SINGLE-CRYSTAL NAPHTHALENE-d_8. Lloyd, Roger V.; Wood, David E. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 56: No. 2, 916-21(15 Jan 1972).

The 2-naphthyl radical was prepared by allowing naphthalene-2-t to undergo radioactive decay in a single-crystal naphthalene-d_8 matrix at 77°K. The resulting, oriented 2-naphthyl radicals were then studied by EPR at 120°K. The parameters in the spin Hamiltonian were determined to be:

	g	T_1	T_3	T_4
x	2.0046	48.1	36.5	13.4
y	2.0024	65.1	54.7	21.8
z	2.0035	54.6	38.9	18.9,

where the hyperfine tensor elements are in megahertz, the x direction is $\perp$ to the plane of the radical, the z direction is $\parallel$ to the broken bond (strictly true for g tensor only), and the y direction is in the plane of the radical $\perp$ to x and z. These tensor elements are very nearly the same as reported for the 2-naphthyl radical in argon at 4°K with the exception that the g tensor elements are uniformly larger by ~0.0011 in naphthalene-d_8. Examination of the g shifts from free spin indicates that the unpaired-electron σ orbital is approximately equally distant from the highest occupied π orbital and the lowest unoccupied π orbital. An INDO calculation based on the x-ray diffraction determined geometry of naphthalene gives the proper relative magnitude of the coupling constants for protons number one and three whereas the "standard geometry" gives an inverted result. There are only two magnetically inequivalent sites in the unit cell as a result of reorientation of the 2-naphthyl radical about its long axis. (auth)

11858 REACTIONS OF THE GASEOUS CARBONIUM IONS FROM THE DECAY OF [1,2-$^3H_2$]-CYCLOPENTANE. Babernics, L. (Inst. of Isotopes, Budapest); Cacace, F. J. Chem. Soc., B; No. 12, 2313-16(1971).

The nature and the reactions of the gaseous ions formed from the β decay of a tritium atom in cyclopentane were investigated by a tracer technique. [1,2-$^3H_2$]Cyclopentane was allowed to decay in cyclopentane, at pressures ranging from 10 to 700 Torr, and the radioactive decay products were analyzed by radio gas-chromatography. The results suggest that over 90% of the β transitions lead to the formation of $C_5H_9T^+$ daughter ions with little or no excitation energy, which retain their cyclic structure unchanged. The small fraction of the ions that receive a significant excitation energy from the nuclear transition undergo isomerization and fragmentation processes, which lead to linear C_1-C_5 tritiated hydrocarbons. The results support the conclusions reached in previous kinetic and mass spectrometric studies on the distribution of the excitation energy within the daughter ions from the decay of simple tritiated molecules. The mechanisms responsible for the formation and the reactions of the gaseous carbonium ions are discussed, and compared with the corresponding process observed in the solution chemistry of the cyclopentyl cation. (auth)

11859 USE OF TRANSURANIUM ELEMENTS. Mueller, Werner (Europaeische Institut fuer Transurane, Karlsruhe, Ger.). Chem. Ztg.; 95: No. 6, 285-94(Mar 1971). (In German).

Transuranium elements emit photons, α particles, and neutrons, the interaction of which with matter is the basis for the application of these elements in science, medicine, and technology. Gamma sources with ^{241}Am are used for radiography, for measuring thickness and concentrations, and for producing x-ray fluorescence. Backscattering of α particles and the α-decay heat can be converted into electrical or mechanical energy in radionuclide batteries or thermal engines. Neutrons that are generated in (α,n) reactions or by spontaneous fission are used for irradiation (radiotherapy) and activation (radiodiagnosis, mineral prospection, or air pollution control). Neutron absorption and scattering are the basis for neutron radiography or the determination of light elements (e.g., in water or mineral oil). Among the examples cited, special emphasis is given to the application of ^{238}Pu in pacemakers and heart assist pumps as well as the numerous possibilities for the use of portable ^{252}Cf sources. (auth)

11860 CHEMICAL EFFECTS OF NEUTRON CAPTURE IN THIOANTIMONY COMPOUNDS. Facetti, J. F.; Colman, H. D. (Univ., Asuncion, Paraguay). J. Inorg. Nucl. Chem.; 33: No. 12, 4019-23(Dec 1971).

The distribution of the valence states of radioantimony was studied in a number of neutron irradiated thioantimony compounds. The high radiochemical yield of Sb(V) seemed to be related to the covalent character of the Sb–S bond, to the degree of hydration of the compounds, and to the radiation damage. (auth)

11861 SOLID SOLUTIONS OF HELIUM IN TITANIUM CONTAINING UP TO 30 AT. PERCENT OF HELIUM. Rodin, A. M.; Surenyants, V. V. Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 5, 612-14(May 1971).

Translated from Zh. Fiz. Khim.; 45: No. 5, 1094-8(May 1971).

The desorption of helium from titanium tritide and metallic titanium in the presence of considerable helium concentrations (up to 30 at. %) was investigated. The rate of evolution of helium depends to a considerable degree on its concentration in the specimen. ^3He present at a concentration of 22 at. % is retained

by titanium tritide much more firmly than tritium. Curves representing the rate of evolution of helium from titanium were recorded for helium concentrations between 8 and 30 at. %. (auth)

Separation Processes

Refer also to abstracts 11678, 11831, 11923, 12000, 12063, 14225, and 14461.

11862 (NAS-NS-3113) CATION-EXCHANGE TECHNIQUES IN RADIOCHEMISTRY. Massart, D. L. (National Academy of Sciences–National Research Council, Washington, D. C. Committee on Nuclear Science). Dec 1971. 195p. Dep. NTIS.

A monograph on cation exchange techniques in radiochemistry is presented that includes theory; techniques, physicochemical basis of separations; applications of the principal resin eluting agent systems; cation-exchange separations of the elements; and thirteen procedures. (714 references.) (D.H.M.)

11863 (ORNL-TM-3141) ENGINEERING DEVELOPMENT STUDIES FOR MOLTEN-SALT BREEDER REACTOR PROCESSING NO. 6. McNeese, L. E. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 84p. Dep. NTIS.

A combined flowsheet for processing MSBR fuel salt by fluorination–reductive extraction and the metal transfer process was devised. Axial dispersion in open bubble columns was measured. The applicability of continuous fluorinators to MSBR processing is considered. Radio-frequency induction heating is being studied as a method for generating heat in molten salt studies of frozen-wall fluorinators with nonradioactive salt. Data obtained in the MSRE Distillation Experiment for the effective relative volatilities of fission products were examined. Equipment was fabricated for studying and demonstrating the metal transfer process for removal of rare earths from MSBR fuel salt. A static cell electrolysis experiment was made in an all-metal cell to determine whether the presence of quartz contributed to the formation of the black material found in the salt phase in other electrolysis experiments. A continuous process for purification of molten salt is being studied. In the semicontinuous reductive extraction experiments, a new column was added and additional studies made. (M.C.G.)

11864 (ORNL-TM-3622) CALCULATED LIQUID-VAPOR EQUILIBRIA IN THE SYSTEMS: CO_2–Xe AND CO_2–Kr AT -55 TO +5°C. Davis, W. Jr. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 41p. Dep. NTIS.

Liquid–vapor equilibria in the binary systems CO_2–Xe and CO_2–Kr were calculated for pressures of 6 to 40 atm (approximately –55 to +5°C) in terms of nonideal solution–nonideal vapor theories, as well as in terms of the simpler nonideal solution–ideal vapor and ideal solution–ideal vapor theories. These calculations were performed to provide a basis for the design of a low-temperature distillation process for separating xenon and krypton (particularly their radioactive isotopes) from CO_2 produced by burning the graphite matrix of High-Temperature Gas-Cooled Reactor fuels. Such separation is shown to occur with separation factors of about 2.5 to 3, for Xe–CO_2 and 8 to 12 for Kr–CO_2 at temperatures in the range –40 to –50°C, corresponding to pressures in the range 10 to 6 atm for solutions containing up to 2 mole % xenon or krypton in liquid CO_2. Comparison of the available experimental data for the system CO_2–Kr with calculated separation factors shows an agreement that is as good as might be expected in view of the uncertainties in the thermochemical properties of krypton. (auth)

11865 (RT/CHI-(71)6) SYSTEM FOR ELECTROLYTIC DISSOLUTION OF A CARBIDE-BASE URANIUM–THORIUM FUEL IN A GRAPHITE MATRIX. STUDY OF A CELL FOR THE JUELICH REACTOR FUEL. Beone, G.; Lazzaretto, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 13 Apr 1971. 63p. (In Italian). Dep. NTIS (U. S. Sales Only).

Studies and tests so far done are summarized. The electrolytic disintegration seems to be a possible solution for the head-end reprocessing of HTGR fuels. A cell for the electrolytic disintegration of spherical fuels from the Juelich reactor is being studied. (auth)

11866 (UCLA-12-849) CARRIER-FREE ISOLATION OF INDIUM FROM SILVER AND CADMIUM BY LIQUID–LIQUID EXTRACTION. Wood, R. A.; Wakakuwa, S. T.; MacDonald, N. S. (California Univ., Los Angeles). [1971]. Contract AT(04-1)-Gen-12. 15p. Dep. NTIS.

An analytical method was developed for the rapid and carrier-free separation of 2.81-d ^{111}In produced by the reactions $^{109}Ag(^4He,2n)^{111}In$ and $^{110}Cd(d,n)^{111}In$. The method is based upon the fact that indium in the presence of macro-concentrations of Ag(I) and Cd(II) preferentially extracts into n-heptane solutions of bis(2-ethylhexyl) hydrogen phosphate (HDEHP) from aqueous nitric acid media. The Ag(I) and Cd(II) remain quantitatively in the aqueous phase. The distribution ratios (K) vary from greater than 10^3 for In(III) to less than 10^{-2} for Ag(I) and Cd(II). The indium is quantitatively stripped from the solvent phase with HCl. The total separation time is less than 10 min. In the present investigation K was studied with respect to acid-solvent dependence, equilibration, and back extraction. Optimum conditions for maximum extraction were determined. (auth)

11867 INVESTIGATION OF THE SECONDARY ADSORPTION OF EUROPIUM ON $SrSO_4$. I. INFLUENCE OF THE CONCENTRATION OF THE INTRINSIC ION OF THE PRECIPITATE. ISOTHERM OF ADSORPTION. Ishina, V. A.; Mosevich, A. N.; Frenklikh, M. S.; Bandi, D. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 187-90(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 185-8(Mar-Apr 1971).

The secondary adsorption of europium on a crystalline precipitate of $SrSO_4$ was studied under conditions of a variable concentration of SO_4^{2-} in solution. The dependence of the coefficient of adsorption Q of europium on the concentration of the intrinsic ion of the precipitate SO_4^{2-} in solution agrees with the Ratner theory. The adsorption isotherm of europium on a precipitate of $SrSO_4$ was taken in the presence of a constant concentration of SO_4^{2-} in solution. The dependence of the amount of adsorbed europium on its equilibrium concentration in solution obeys the Freundlich equation. (auth)

11868 INVESTIGATION OF THE SECONDARY ADSORPTION OF EUROPIUM ON $SrSO_4$. II. INFLUENCE OF EXTRANEOUS CATIONS ON THE ADSORPTION OF EUROPIUM. Ishina, V. A.; Mosevich, A. N.; Frenklikh, M. S.; Bandi, D. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 191-6(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 189-96(Mar-Apr 1971).

The dependence of the inverse adsorption coefficient 1/Q of europium ions on strontium sulfate on the concentration of a number of cations of different valences was studied. With increasing concentration of the extraneous cation in solution (m_1), the value of the reciprocal adsorption coefficient increased. The dependence of $(1/Q)^{n_1}$ on $m_1^{n_1}$ (n_1 is the valence of the extraneous ion) was linear, and in the case of multiply charged ions, for high values a deviation from linearity was observed in the direction of an increase in the slope of the curve. The cations investigated can be arranged in the following series with respect to desorbing ability: $Th^{4+} > La^{3+} > Ba^{2+} > Al^{3+} > Mg^{2+} > H^+ > Na^+$. (auth)

11869 INVESTIGATION OF THE SECONDARY ADSORPTION OF EUROPIUM ON $PbSO_4$. Ishina, V. A.; Mosevich, A. N.; Frenklikh, M. S.; Bandi, D. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 197-202(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 196-203(Mar-Apr 1971).

The secondary adsorption of europium ions on a suspension of $PbSO_4$ was studied by the radioactive tracer method in the presence of various contents of sulfate ions in the solution. The change in the coefficient of adsorption of europium with changing SO_4^{2-} ion concentration occurs according to the Ratner theory. The equilibrium distribution of europium between a $PbSO_4$ precipitate and a solution with a constant concentration of sulfate ions was investigated. The shape of the isotherm obtained corresponds to the Freundlich equation. The dependence of the reciprocal of the adsorption coefficient on the concentration was investigated in the solution of extraneous cations of various chemical natures. Both the shape of the indicated function and the relative desorbing ability of the ions are analogous to those observed earlier for $BaSO_4$ and $SrSO_4$. (auth)

11870 EXTRACTION EQUILIBRIA IN THE SCANDIUM CHLORIDE–WATER–HYDROCHLORIC ACID–TRIBUTYL PHOSPHATE SYSTEM. Samodelov, A. P. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 203-7(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 203-8(Mar-Apr 1971).

The mechanism of extraction of scandium from hydrochloric acid solutions by tributyl phosphate was studied. Scandium is extracted from the aqueous solutions in the form of the hydrochloride $HScCl_4$. The composition of the solvate in the form of which scandium is extracted into the organic phase, that is, $ScCl_3 \cdot HCl \cdot 2TBP$, was determined from the results of a chemical analysis of the products of extraction, as well as from results of a measurement of the electric conductivity of the organic phase, the infrared spectra, and the curves of heating of the extraction products. The influence of hydrochloric acid and scandium

chloride in a broad range of concentrations on the mutual distribution of these compounds and water between the phases is discussed. A hypothesis of a substantial degree of polymerization of scandium chloride in an aqueous solution of hydrochloric acid is advanced. (auth)

11871 INVESTIGATIONS OF THE DISTRIBUTION OF AMERICIUM AND CURIUM IN THE PROCESS OF EXTRACTION WITH METHYLDIOCTYLAMMONIUM NITRATE FROM SOLUTIONS OF LITHIUM NITRATE. Chudinov, E. G.; Pirozhkov, S. V.; Stepanchikov, V. I. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 208-14(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 208-15(Mar-Apr 1971).

The possibility of separating Am and Cm in the trivalent state by extraction with methyldioctylammonium nitrate from solutions of $LiNO_3$ was studied using a rotatable second-order plan, as a function of three variables: the concentrations of the ammonium compound and $LiNO_3$ and the pH. Second-order regression equations were obtained, relating the separation factor and the distribution coefficients to the change in these parameters. (M.C.G.)

11872 ADSORPTION OF ^{91}Y AND ^{137}Cs FROM SEA WATER AND AQUEOUS SOLUTIONS OF VARIOUS AGES ON GLASS AND TEFLON. Skul'skii, I. A.; Lyubimov, A. A. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 272-5(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 272-5(Mar-Apr 1971).

The adsorption of ^{91}Y from aqueous solutions at pH = 2 to 3 on Teflon in a definite time interval (10 min) does not depend on the age of the solutions. This indicates a stability with time of the chemical forms of existence of yttrium in solutions at pH $\leq$ 3. The adsorbability of ^{91}Y from aqueous solutions and seawater on glass and Teflon at pH = 4.35 and 8.0 increases with the age of the solutions. The maximum adsorption ability of ^{91}Y is manifest after approximately 24 h at pH = 8.0 and only on the fifth to sixth day at pH = 4.35. After the maximum is reached, the adsorbability of ^{91}Y drops sharply. Raising the temperature of the solutions from 15 to 18 to 25°C accelerates the reaching of a state of ^{91}Y in which the adsorbability of the radioisotope on glass and Teflon is a maximum. At both temperatures the maximum adsorption is accompanied by a sharp drop in the adsorption capacity of ^{91}Y. The adsorption of ^{137}Cs from seawater on glass and Teflon is substantially smaller than the adsorption of ^{91}Y and does not depend on the age of the solutions. Part of the ^{137}Cs is adsorbed irreversibly. The nature of the interrelationships between the age of the solutions and the values of the adsorption coefficients of ^{91}Y and ^{137}Cs can be explained by the influence of processes of hydrolysis, which, developing with time, leads to the formation of forms of ^{91}Y differing in their adsorption ability and does not affect the state of ^{137}Cs. (auth)

11873 COMPARATIVE INVESTIGATION OF THE ADSORPTION OF ^{90}Y AND ^{91}Y FROM SEA WATER ON TEFLON. Skul'skii, I. A.; Lyubimov, A. A. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 276-8(Mar-Apr 1971).

translated from Radiokhimiya; 13: No. 2, 276-8(Mar-Apr 1971).

The adsorbability of ^{90}Y and ^{91}Y from seawater on Teflon increases with the age of the solutions and reaches maximum values after three to four days. Then the adsorbability of ^{91}Y begins to decrease, while the adsorbability of ^{90}Y remains at approximately the same level for several weeks. The increase in the adsorption capacity of ^{90}Y and ^{91}Y with age of the solutions can be explained by the development of hydrolytic processes and by the formation of products of hydrolysis of microconcentrations of yttrium that are unstable in solution and are readily adsorbed on a hydrophobic surface of Teflon. The increase in the adsorbability of ^{91}Y, observed three to four days after the preparation of the solutions, is apparently due to further association of the hydrolysis products, with the formation of larger and less adsorbable forms of the radioisotope. The conservation of a higher adsorbability of ^{90}Y in comparison with ^{91}Y may be due to the fact that the age of the hydrolysis products of this radioisotope is limited by its average lifetime (about four days). Therefore, after three to four days, a unique equilibrium is established in solution between the rate of radioactive renewal of ^{90}Y and the rates of various hydrolytic conversions of this radioisotope. After two to three half-lives (100 to 200 h), the state and adsorbability of ^{90}Y practically ceased to depend on the age of the solutions. (auth)

11874 INFLUENCE OF HYDROLYSIS ON THE ADSORBABILITY OF RADIOISOTOPES. Skul'skii, I. A.; Lyubimov, A. A. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 279-82(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 278-81(Mar-Apr 1971).

The adsorbability of $^{144}Ce^{3+}$, $^{144}Ce^{4+}$, $^{144}Pr^{3+}$, and $^{91}Y^{3+}$ from seawater on Teflon depends on the age of the solutions. The influence of age on the adsorption and desorption of radioisotopes can be explained by the different rates and depths of the processes of hydrolysis of the element to be investigated in seawater. Microconcentrations of $^{144}Ce^{3+}$ and $^{144}Ce^{4+}$ in seawater are capable of forming hydrolysis products, the structural complexity and volume of the particles of which are sufficient for retention of the daughter $^{144}Pr^{3+}$ in them. As a result of retention, the short-lived $^{144}Pr^{3+}$ entirely repeats the age changes in the adsorbability observed for the long-lived parent radioisotope $^{144}Ce^{3+}$ or $^{144}Ce^{4+}$. In contrast to the short-lived ^{144}Pr, the hydrolysis products of ^{91}Y can undergo more prolonged conversions. Therefore, ^{91}Y exhibits its own chemical individuality in adsorption with time, even in the case when it is introduced into the solution in the form of a mixture with $^{144}Ce^{3+}$, and probably is subjected at first to copolymerization with the hydrolysis products of microconcentrations of cerium. (auth)

11875 DEPENDENCE OF THE EXTRACTION CAPACITY OF AMINES ON THEIR STRUCTURE. Rozen, A. M.; Nagnibeda, Z. I. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 286-9(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 284-7(Mar-Apr 1971).

The constants of extraction of nitric acid, uranyl nitrate, and plutonium nitrate in the series of primary amines–quaternary ammonium bases were found. A linear correlation was obtained between the extraction constants and the characteristics of the structure of the amine cation (the sum of the electronegativities of the substituent group, the sum of the Taft constants, and the number of alkyl groups). The dependence of the extraction constant on the chain length is characterized by a weak maximum (at n_C = 9 to 12) for tertiary amines; for secondary and primary amines at n_C = 12, no maximum was detected. (auth)

11876 MATHEMATICAL DESCRIPTION OF THE DISTRIBUTION OF URANYL NITRATE AND NITRIC ACID IN THE REGION OF LOW METAL AND ACID CONCENTRATIONS. Rozen, A. M.; Kartasheva, N. A. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 293-5(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 289-91(Mar-Apr 1971).

The mathematical model of the TBP extraction process was refined and compared with experimental data. (M.C.G.)

11877 SEPARATION OF RADIOACTIVE ALKALINE EARTH ELEMENTS. I. EXTRACTION OF OXINATES OF THE ALKALINE EARTH ELEMENTS. Prokopchuk, Yu. Z.; Brezhneva, N. E.; Korpusov, G. V. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 244-50(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 245-52(Mar-Apr 1971).

The dependences of the distribution coefficients of calcium, barium, and strontium oxinates in extraction by TBP on the concentration of oxine, TBP, ammonia, sodium hydroxide, and certain salts were studied and the coefficients of separation of the alkaline earth elements were also determined. A probable mechanism of the extraction is proposed and values of equilibrium constants of the extraction reaction estimated. (auth)

11878 STATUS OF DRY REPROCESSING DEVELOPMENT. Aochi, Tetsuo; Yagi, Eiji (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 17: No. 3, 53-8(Mar 1971). (In Japanese).

There are two methods for reprocessing spent nuclear fuel. The dry reprocessing process is summarized, centering around a fluoride volatility process. Research and development of the fluoride volatility process have been carried out by U. S. AEC and in France. For reprocessing highly enriched uranium fuel, this process is promising for industrialization. The fluoride volatility process has been also applied for the fuel reprocessing in fast reactors. However, for the fuel reprocessing in light water reactors, this process has many difficult problems. Several problem areas are considered: namely, decladding, powdering, making fluorides of U and Pu, separation of Pu from U, refining and conversion of U and Pu, and recovery of by-products. (Japan)

11879 EXCHANGE OF BIVALENT CATIONS ON THE CRYSTALLINE ANTIMONIC CATION EXCHANGER. Novikov, B. G.; Belinskaya, F. A.; Materova, E. A. (Leningrad State Univ.). Vestn. Leningrad. Univ., No. 4, Fiz., Khim.; No. 1, 35-42(Feb 1971). (In Russian).

Ion-exchange properties of a crystalline antimonic cation exchanger were investigated. The affinity of the ion exchanger to bivalent cations decreases in the series $Cd^{2+} > Sr^{2+} > Ba^{2+} > Ca^{2+} \gg Mg^{2+}, Ni^{2+}$. The thermodynamic characteristics of $M^{2+} \rightarrow H^+$ exchange were calculated and the possible causes of selectivity of the cation exchanger to M^{2+} ions discussed. (auth)

11880 ADSORPTION BEHAVIOUR OF ^{99}Mo(VI), ^{238}U(VI), ^{95}Zr(IV), AND ^{95}Nb(V) ON ALUMINA. Shehata, M. K.; El-Bayoumy, S.; El-Garhy, M. (Atomic Energy Establishment, Cairo). J. Radioanal. Chem.; 8: No. 2, 231-4(Aug 1971).

The distribution of Mo(VI) and the interfering radiocontaminants U(VI), Zr(IV), and Nb(V) were investigated between chromatographic alumina and aqueous hydrochloric acid solutions of concentrations ranging from 0.5 to 11M. At low acidities (less than 1M HCl) the distribution coefficients increased with the decrease of acid concentration, while in the region of 2 to 4M they increased with the increase of the acid concentration. Above 4M HCl, the increase in K_D continued with the acid concentration for both Zr(IV) and Nb(V), but constant values were reached for U(VI) and Mo(VI). (auth)

11881 STUDY OF THE BEHAVIOR OF ALKALI METALS ON HYDRATED ANTIMONY PENTOXIDE. Bourrelly, I. N.; Deschamps, N. (CEN de Saclay, Gif-sur-Yvette, France). J. Radioanal. Chem.; 8: No. 2, 303-12(Aug 1971). (In French).

The behavior of Na^+, K^+, Rb^+, and Cs^+ ions on hydrated antimony pentoxide (HAP) was studied, in various acid media and in ammonium hydroxide. The retention capacity of HAP for the alkali metal ions, as well as their retention rate, has been determined in all the media studied. Curves showing the variation of distribution coefficient values with acid or base concentration are presented. (auth)

11882 EXTRACTION OF THE CESIUM ION WITH SOME NITROPHENOLS INTO NITROBENZENE. I. DISTRIBUTION STUDIES. Koyama, Mutsuo; Tochiyama, Osamu; Fujinaga, Taitiro (Kyoto Univ.). Bull. Chem. Soc. Jap.; 44: No. 6, 1591-6(Jun 1971).

The liquid–liquid extraction of alkali metal nitrophenolates was studied using nitrobenzene as the extracting solvent. Nitrophenol derivatives such as o-, m-, p-nitrophenols, α-dinitrophenol, and picric acid were chosen here in order to examine the effect of their steric characters and pK values on the distribution equilibrium. It was concluded that: all the cesium nitrophenolates extracted into nitrobenzene were mainly in the dissociated form, the extraction of m- and p-nitrophenolates proceeds by the stepwise adduct formation with free phenols, whereas little tendency of adduct formation was observed with the picrate system; α-dinitrophenolate has a character between the other two; and the distribution of o-nitrophenolate is negligible. A detailed discussion is given of the phenomena in terms of ionic equilibria in both the aqueous and organic phases. (auth)

11883 ESTIMATION OF NEPTUNIUM IN A FUEL REPROCESSING PLANT. Srinivasan, N.; Ramaniah, M. V.; Patil, S. K.; Ramakrishna, V. V. (Bhabha Atomic Research Centre, Trombay, India). J. Radioanal. Chem.; 8: No. 2, 223-9(Aug 1971).

Solutions at various stages of the Purex process used at Trombay were analyzed for their ^{237}Np content to know the path of neptunium in the process. The results of these analyses, though not very quantitative, revealed that in the co-decontamination cycle, neptunium is extracted along with uranium and plutonium almost quantitatively while in the partitioning cycle the extraction is reduced to about 50%. Analysis of various oxidation states of neptunium in the feed of the first cycle showed that neptunium is predominantly present as Np(V). (auth)

11884 SEPARATION AND REFINEMENT OF RADIOACTIVE ISOTOPES FROM REPROCESSING WASTES. Amano, Hiroshi (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 17: No. 7, 10-15(Jul 1971). (In Japanese).

Effective use of radioactive wastes from spent fuel reprocessing is necessary in order to cut reprocessing costs. A separation method of fission products from primary extraction wastes is presented. Useful materials in the reprocessing of wastes become the source of many isotopes, e.g., ^{90}Sr, ^{137}Cs, ^{147}Pm, and ^{144}Ce. Solvent extraction, ion exchange, and flocculation methods are described briefly with respect to operational conditions and materials. It is shown that the gaseous fission product, ^{85}Kr, can be separated by adsorption and absorption methods. As the separation of Np and Am may be possible by the Purex method, recovery of these materials has been considered. (Japan)

11885 CATION EXCHANGE CHARACTERISTICS OF SOME METAL IONS IN NITRIC ACID–AMMONIUM ACETATE MEDIUM. Mahan, Ashok; Ghose, Animesh K.; Dey, Arun K. (Univ. of Allahabad, India). Separ. Sci.; 6: No. 6, 781-9(Dec 1971).

Cation exchange equilibrium distribution coefficients (Λ) with Amberlite IR-120 were determined for 20 metal ions in media consisting of mixtures of 0.1 M HNO_3 and varying concentrations (0.01, 0.05, 0.25, and 1.2 M) of ammonium acetate. The metal concentrations were so chosen that the ratio of total amount of cation to total resin capacity $\approx$0.4, sufficient to ensure exchange. The values of separation factors of various metal ion pairs have also been evaluated, and separation possibilities for ions in a number of binary and ternary mixtures have been proposed. (auth)

11886 FRACTIONATION OF ^{18}O AND ^{13}C ISOTOPES BY CHEMICAL EXCHANGE OF CARBON DIOXIDE WITH AMINE CARBAMATES. Agrawal, Jitendra P. (Columbia Univ., New York). Separ. Sci.; 6: No. 6, 819-29(Dec 1971).

The distribution of ^{18}O and ^{13}C isotopes in a chemical exchange system of carbon dioxide and amine carbamates was studied. A comparison of isotope separation by 15 amines shows little dependence on the nature of the amine. Effects of amine concentration indicate that diffusion of the reacting species plays a significant role in these systems. This is in conformity with the observation that the viscosity of the amine solutions saturated with carbon dioxide increases rapidly with amine concentration. (auth)

11887 ENRICHMENT OF ^{13}C BY CHEMICAL EXCHANGE OF CARBON DIOXIDE WITH AMINE CARBAMATES IN NONAQUEOUS SOLVENTS. Agrawal, Jitendra P. (Columbia Univ., New York). Separ. Sci.; 6: No. 6, 831-9(Dec 1971).

Enrichment of ^{13}C by the exchange of carbon dioxide with its amine carbamates in nonaqueous solvents was studied. Optimum operating conditions for the fractionation of ^{13}C in a packed countercurrent column were determined. A comparison of the method with other competitive methods indicates that the process is fairly attractive at its present stage of development. (auth)

11888 SYNERGISTIC EFFECTS IN THE EXTRACTION OF AMERICIUM AND YTTRIUM WITH VARIOUS ADDUCT-FORMING AGENTS. Keller, C.; Feinauer, D.; Schweizer, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta; 16: No. 3-4, 185-90(Dec 1971). (In German).

In the extraction of Am^{3+} and Y^{3+} from an aqueous solution with thenoyltrifluoroacetone (HTTA)/$CHCl_3$ in the presence of various adducting agents A (e.g., ether, sulfides, sulfones, nitro compounds, ketones), the formation of adduct chelates $M(TTA)_3 \cdot iA$ ($1 \leq i \leq 4$) improves transfer of the metal ion into the organic phase (synergistic extraction). The most stable adduct chelates of the adducting agents studied in this work are formed by dibutyl sulfoxide, while the most unstable adduct chelates were found for 1-nitrobutane. A marked steric effect was detected for the series of isomeric methyl butyl ketones; this effect is more pronounced with Y^{3+} than with Am^{3+}. However, no general relationship was observed between the adduct stability constant log $\beta i'$ and specific properties of all complexing agents. Meaningful comparisons can be made only between the adduct chelates of homologous series, e.g., R_2O, R_2S, and R_2Se. (auth)

11889 ISOTOPIC FRACTIONATION IN A THERMAL ION SOURCE. Kanno, Hitoshi (Tokyo Univ.). Bull. Chem. Soc. Jap.; 44: No. 7, 1808-12(Jul 1971).

Isotopic fractionation behavior in a thermal ion source was studied theoretically. An equation relating to the observed isotope ratio with the evaporated fraction of the sample was derived under conditions where two kinds of chemical species, atomic (atomic ions and neutral atoms) and molecular (molecular ions and molecules) species, simultaneously evaporate from the filament. It was demonstrated that integrations of all ion currents for two isotopes do not necessarily give a true ratio of the two isotopes in the sample when two evaporating chemical species are ionized at different rates. Isotopic fractionation curves for halides and elements of lithium, potassium, and rubidium are presented. (auth)

11890 DEVELOPMENT TENDENCIES IN AQUEOUS PROCESSING OF IRRADIATED NUCLEAR FUELS. Koch, Guenter (Kernforschungszentrum, Karlsruhe, Ger.). Chem. Ztg.; 95: No. 6, 275-84(Mar 1971). (In German).

The chemical processing of irradiated nuclear fuels is at present performed by counter-current solvent extraction with tributyl phosphate as the extractant. The basic aspects of this process are described. Development work is aimed at the accommodation of this successful technique to fuels from future advanced power reactors. Besides, enlargement of the plant throughput and simplification of single process steps are significant points of view. Work is concentrated on the development of head-end processes, on the

improvement and simplification of the extraction and separation of fuel and breed materials, on controlling the radiolysis effects, and on the development of plant equipment. (auth)

11891 CHEMISTRY AND TECHNOLOGY OF FUEL ELEMENTS WITH SPECIAL CONSIDERATION TO FAST-BREEDER FUEL ELEMENTS. Kuhn, Karl-Dieter; Muehling, Guenter; Scheffler, Knut (ALKEM GmbH, Wolfgang, Ger.). Chem. Ztg.; 95: No. 6, 261-9(Mar 1971). (In German).

The technology of fast breeder fuel elements is mainly determined by the properties of plutonium. Sintered UO_2-PuO_2 pellets in stainless steel tubes are used as fuel pins. The fabrication process is based on procedures developed for the fabrication of thermal UO_2 fuel. In addition compounds such as carbides and nitrides are discussed, but up to now only carbides have been produced in a pilot plant scale. To recover the valuable fissile material from scrap and waste, chemical separation and purification processes have to be performed. (auth)

11892 RADIOCHEMICAL SEPARATIONS. Crouthamel, C. E.; Heinrich, R. R. (Argonne National Lab., Ill.). pp 5467-5511 of Treatise on Analytical Chemistry. Vol. 9, Pt. I. /Kolthoff, I. M. (ed.). New York; John Wiley and Sons, Inc. (1971).

The following topics are discussed: isotopic exchange; carrier-free separations, including coprecipitation, solvent extraction, ion exchange, paper chromatography, and volatilization techniques; electrochemical methods; and radiocolloids. An appendix on radiochemical procedures is included. (258 references.) (J.G.B.)

11893 INDIVIDUAL EXTRACTION CONSTANTS OF UNIVALENT IONS IN THE SYSTEM WATER–NITROBENZENE. Rais, J. (Inst. of Nuclear Research, Rez, Czech.). Collect. Czech. Chem. Commun.; 36: No. 9, 3253-62(Sep 1971).

On the assumption that tetraphenylarsonium and tetraphenylborate ions enter the organic phase with the same readiness, the individual extraction constants of 22 univalent ions in the system water–nitrobenzene were determined. Comparison with some other nonthermodynamic assumptions were also made. The ion Cs^+ is less solvated by nitrobenzene than it is hydrated by water. Pleskov's postulate of equal solvation of the Rb^+ ion in various solvents is criticized; a different reference ion is proposed. (auth)

11894 ZIRCONIUM AND HAFNIUM EXTRACTION FROM SULFURIC ACID–CHLORIDE SOLUTIONS BY TRIBUTYL PHOSPHATE. Zharovskii, F. G.; Kostova, R. V. (Kiev State Univ.). Ukr. Khim. Zh.; 37: No. 8, 826-8(Aug 1971). (In Russian).

The effects of chloride ion on the extraction of Zr and Hf from H_2SO_4 solutions by TBP were investigated. Zr and Hf were more efficiently extracted from a mixture of SO_4^{2-} and Cl^- (keeping total acidity constant) than from solutions of the individual acids. For higher total acidity of the solution, the chloride ion effect was greater. The distribution coefficient exhibited a maximum at about 8 M HCl + 2M H_2SO_4 for Hf, and at about 7 M HCl + 3M H_2SO_4 for Zr. (K.S.W.)

11895 EXTRACTION OF THE CESIUM ION WITH SOME NITROPHENOLS INTO NITROBENZENE. II. HOMOCONJUGATION STUDIES BY MEANS OF CONDUCTIVITY MEASUREMENTS. Tochiyama, Osamu (Tohoku Univ., Sendai); Koyama, Mutsuo; Fujinago, Taitiro. Bull. Chem. Soc. Jap.; 44: No. 11, 3028-32(Nov 1971).

In connection with the liquid–liquid extraction study of alkali metal nitrophenolates, ionic equilibria taking place in the systems were studied by means of conductivity and solubility measurements. It was revealed that the adduct formation of p- and m-nitrophenolates consisted of homoconjugation, that is, free nitrophenols are attached not to cations, but to the nitrophenolate anions, thus forming the larger anions and being stabilized in the organic phase. Homoconjugation constants of the nitrophenolates, which are independent of the cations present, were measured. The difference in extraction behaviors was interpreted in terms of the solubilities in both aqueous and organic phases and in terms of the homoconjugation constants. (auth)

11896 GAS CHROMATOGRAPHIC SEPARATION OF VOLATILE FLUORIDES USING A HYDROGEN DIFFUSION FLAME AS DETECTOR. Dagnall, R. M. (Imperial Coll. of Science and Tech., London); Fleet, B.; Risby, T. H.; Deans, D. R. Anal. Lett.; 4: No. 8, 497-506(1971).

An account is given of the preparation, separation, and detection of volatile fluorides. These fluorides are formed by the reaction of chlorine trifluoride with the elements (W, Mo, Re, B, P, Se, Si, S, and Te) in a specially designed polytetrafluoroethylene reaction vessel enclosed in an HF coil. A comparison is also made of a spectroscopic detector with a katharometer for the detection of the fluorides. The performance of a newly developed spectroscopic detector is compared with a conventional katharometer detector. (auth)

11897 ZIRCONIUM AND HAFNIUM EXTRACTION FROM ALCOHOL–SULFURIC ACID SOLUTIONS BY TRIBUTYL PHOSPHATE (TBP). Zharovskii, F. G.; Kostova, R. V. (Kiev State Univ.). Ukr. Khim. Zh.; 37: No. 7, 694-7(Jul 1971). (In Russian).

Extraction of Zr and Hf by 30% TBP in CCl_4 from solutions of $H_2SO_4-H_2O$–alcohol was investigated, where the alcohol was, alternatively, methyl, ethyl, propyl, and isopropyl. The presence of the alcohol significantly increased the extraction of both Zr and Hf; the identity and concentration of the alcohol affected extraction of Hf much more than of Zr. (K.S.W.)

11898 SULFUR ISOTOPE PARTITIONING IN METALLIC SULFIDE SYSTEMS. Kajiwara, Y.; Krouse, H. R. (Univ. of Alberta, Edmonton). Can. J. Earth Sci.; 8: No. 11, 1397-1408 (Nov 1971).

Sulfur isotopic fractionation factors involving pairs of pyrite, pyrrhotite, sphalerite, chalcopyrite, and galena were determined experimentally over the temperature range 250 to 600°C. Since chalcopyrite and pyrrhotite are not stable at higher PS_2 conditions, buffer assemblages were necessary to control PS_2 in experiments with these minerals. Since low PS_2 values and low temperatures are unfavorable to rapid isotope exchange, techniques were devised whereby equilibrium constants could be estimated indirectly in systems where direct measurements are not possible because of the time factor. Current data place the sulfide minerals in the following order of ^{34}S enrichment under equilibrium exchange conditions: pyrite > (pyrrhotite ≃ sphalerite) > chalcopyrite > galena in agreement with theoretical predictions. In agreement with theory the equilibrium exchange constant K for a given mineral pair depends upon temperature as follows: $1000 \ln K \doteq \Delta\delta^{34}S = AT^{-2}$, where A denotes a constant. The A values for various mineral pairs were determined with ±10% uncertainties as follows: 11.0×10^5 (py–gn), 8.0×10^5 (sp–gn), 6.5×10^5 (cp–gn), 4.5×10^5 (py–cp), 3.0×10^5 (py–sp, py–po), 1.5×10^5 (sp–cp, po–cp), and ≃0 (sp–po). (auth) (Canada)

11899 EXTRACTION OF Np(IV) AND HNO_3 BY TRIPHENYLPHOSPHINE OXIDE. El-Naggar, H. A.; Shehata, M. K.; Abdel-Gawad, A. S. (Atomic Energy Establishment, Inshas, Egypt). Z. Anorg. Allg. Chem.; 383: No. 2, 191-8(Jul 1971).

The extraction of Np(IV) and HNO_3 from aqueous solutions containing only this acid (1 to 10 M) was studied with solutions of triphenylphosphine oxide (TPPO) in carbon tetrachloride, benzene, and chloroform. The species $TPPO \cdot HNO_3$ and $Np(NO_3)_4 \cdot 2TPPO$ are the most predominantly extracted species; there is also experimental evidence for $Np(NO_3)_4 \cdot TPPO$. An equilibrium "constant" of 0.7 was calculated for the extraction of HNO_3 with solutions of the reagent in CCl_4. This value fits also the measurements on TPPO in C_6H_6. The position of the solvent $CHCl_3$ is reversed, compared with the extraction of the acid and Np(IV) by the solvents CCl_4 and C_6H_6, respectively. (auth)

11900 MOLYBDENUM ADSORPTION ON ANIONITE AV-17P FROM HNO_3 SOLUTION. Kholmogorov, A. G.; Nadol'skii, A. P.; Il'ichev, S. N.; Kovaleva, M. P. (Irkutsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 3, 64-7(1971). (In Russian).

The anion exchange resin AV-17P with a macroporous structure is a good sorbent for molybdate ion in its polyanionic state. Divinylbenzene (DVB) and isooctane may be used to increase the specific surface of AV-17P (~0.2 m^2/g) to 164 m^2/g (40% DVB) and 64 m^2/g (one part by weight isooctane), respectively. Anionite AV-17P with 8% DVB and 0.8 to 1.0 part by weight isooctane possesses an optimum exchange capacity for MoO_4^{2-}. With increased nitrate ion concentrations (to 200 g/l) Mo is adsorbed best by Anionite AV-17P in the pH range 2.5 to 4.0. (K.S.W.)

11901 MECHANISM OF THE ELEMENTARY ACT OF PROTON TRANSFER. PREEXPONENTIAL FACTOR AND HYDROGEN ISOTOPE SEPARATION FACTOR. Krishtalik, L. I.; Tsionskii, V. M. (Inst. of Electrochemistry, Moscow). J. Electroanal. Chem. Interfacial Electrochem.; 31: No. 2, 363-74(1971).

Various relationships associated with the preexponential factor and the separation factor of hydrogen isotopes are treated in terms of two models of an elementary act of hydrogen discharge, the Horiuti–Polanyi model and the Dogonadze–Kuznetsov–Levich model. The ratio of the preexponential factors for barrierless and normal discharge, the dependence of the preexponential factor and the isotope separation factor on the nature of the metal, the absolute values of the separation factors (with account taken of the

activationless nature of electrochemical desorption), and the different character of the dependence of the separation factor on potential in acid and in alkaline solutions are qualitatively at variance with the Horiuti–Polanyi model, but can be reasonably accounted for in terms of the Dogonadze–Kuznetsov–Levich model. (auth)

11902 EXTRACTION BEHAVIOR IN A Ge(IV)–Mo(VI)–Cr(III) SYSTEM. Lebedeva, L. I.; Muradova, F. A.; Prokof'eva, G. N. Zh. Neorg. Khim.; 16: No. 7, 2025-6(Jul 1971). (In Russian).

The possibility of interaction in a system consisting of Ge(IV)–Mo(VI)–Cr(III) was investigated by means of an extraction method using a $CHCl_3$–butanol mixture as extractant. Neither Cr(III) nor Mo(VI) nor a mixture of the two was extracted from 1 N H_2SO_4 in preliminary tests. Ge(IV) was extracted by the organic phase only as a Ge–Mo complex. However, in extraction tests of the ternary mixture of ions, the presence of Cr(III) reduced the extraction of Mo(VI) into the organic phase, although the extractability of Ge(IV) remained unchanged. (K.S.W.)

11903 EXTRACTION OF $[RuCl_6]^{2-}$ BY ALIPHATIC AMINES. Bol'shakov, K. A.; Sinitsyn, N. M.; Borisov, V. V.; Vaseneva, S. M. (Moscow Inst. of Fine Chemical Tech.). Zh. Neorg. Khim.; 16: No. 7, 1968-73(Jul 1971). (In Russian).

The extraction behavior of Ru(IV) in the form of $[RuCl_6]^{2-}$ from HCl solutions by aliphatic amines was studied. The acidity of the aqueous phase and the time lag prior to extraction had a pronounced effect on Ru recovery. Acidities below 5 M HCl caused hydrolysis of the $[RuCl_6]^{2-}$ ion and a consequent deleterious effect on extraction. In the organic phase containing amine, the formation of the complex, $(AmH)_2[RuCl_6]$, resulted, and the particular compound containing trioctylamine was subjected to careful physicochemical examination. (tr-auth)

11904 PRECIPITATION PRODUCT OF SCANDIUM BY SODIUM THIOSULFATE. Kuntsevich, G. K.; Zolotavin, V. L.; Onosova, S. P.; Indik, V. S. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Neorg. Khim.; 16: No. 7, 1807-11(Jul 1971). (In Russian).

Precipitates were obtained by adding a threefold excess of thiosulfate to solutions of scandium nitrate or chloride at various pH values. The solid products contained scandium sulfite with admixed sulfur, but no thiosulfate. (K.S.W.)

11905 RADIATION STABILITY OF BITUMINIZED RADIOACTIVE WASTES. Koerner, W.; Dagen, A. (Staatliche Zentrale fuer Strahlenschutz, Lohmen, Ger.). Isotopenpraxis; 7: No. 7, 296-302(Jul 1971).

Information concerning the amount of radiolytic hydrogen produced is necessary to obtain radiological safety for disposal of waste blocks produced by bituminization of radioactive wastes. Tests were carried out for irradiation of bitumen B 45 and bitumen B 45–$NaNO_3$ mixture with an external ^{60}Co source or by incorporated $^{90}Sr/^{90}Y$ in air and/or an atmosphere of inert gas. A hydrogen developing rate of $\approx 10^{-2}$ cm^3 g^{-1} Mrd^{-1} was ascertained for estimating dangers of explosion. The rate of swelling of bitumen blocks was $\approx 2 \times 10^{-3}$ cm^3 g^{-1} Mrd^{-1}. The time to reach the explosion limit for a closed storage vault was estimated. (auth)

11906 EXTRACTION OF Eu^{2+} USING AN OXINE DERIVATIVE. Leveque, A.; Rosset, R. (Ecole Superieure de Physique et Chimie Industrielles, Paris). Compt. Rend., Ser. C; 273: No. 17, 1073-6(27 Oct 1971). (In French).

A potentiometric method was used to study the extraction of the Eu^{2+} ion by (7α(O–carbomethoxy–anilino)benzyl)8–hydroxyquinoline (HL) in a chloroform solution. EuL_2, 2HL was extracted in the organic phase, its extraction constant being $10^{-9.4}$. The extraction of Eu^{3+}, Zn^{2+}, and Sr^{2+} ions by the same compound was also studied. (France)

11907 RELATION BETWEEN THE ISOTOPE SEPARATION FACTOR AND EQUILIBRIUM CONSTANTS FOR CARBON ISOTOPE EXCHANGE REACTIONS IN HYDROCARBON SYSTEMS. Galimov, E. M. (Inst. of the Petrochemical and Gas Industry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.): 45: No. 5, 665-7(May 1971).

Translated from Zh. Fiz. Khim.: 45: No. 5, 1187-91(May 1971).

A general expression was obtained for the relation between the separation factor and the equilibrium constant (β-factor) taking into account the presence of nonequivalent atoms in the molecule. The known forms of the relation are approximations (in special cases) to this more general relation. It follows from the form of the expression that isotope separation in hydrocarbon systems and in systems including compounds containing nonequivalent atoms cannot be adequately described by calculating the β-factors for fully isotope-substituted species only, as is usually done, but requires the calculation of β-factors characterising all the nonequivalent isotopic species. (auth)

11908 SEPARATION OF ISOTOPES IN THE FORMATION OF UNSTABLE INTERMEDIATES. Basov, Yu. G.; Panchenkov, G. M. (Moscow State Univ.). Russ J. Phys. Chem. (Engl. Transl.): 45: No. 5, 696-8(May 1971).

Translated from Zh. Fiz. Khim.: 45: No. 5, 1235-7(May 1971).

A method is proposed for calculating the isotopic separation factors of elementary steps involving unstable intermediates. (auth)

11909 LIQUID–LIQUID EXTRACTION OF THE ACTINIDES. Peppard, Donald F. (Argonne National Lab., Ill.). Annu. Rev. Nucl. Sci.; 21: 365-96(1971).

The discussion of liquid–liquid extraction is restricted to its applications in the isolation and purification of individual actinides and in furthering the knowledge on the chemical behavior of individual actinides. Radiochemical determination of the distribution ratio of a specific radionuclide in a given system is described. Extraction stoichiometries are illustrated in selected types of liquid–liquid extraction systems. Extractions of M(VI), (V), (IV), and (III) are discussed. Basic chemistry implications are considered. (249 references) (M.C.G.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 12095–12097.

11910 NUCLEAR CAVITY CONFIGURATION CONTROL. Lanning, William C. (to Phillips Petroleum Co.). U. S. Patent 3,611,933. 12 Oct 1971. Filed 29 Dec 1967.

The configuration of a nuclear cavity is controlled and/or enlarged by placing auxiliary conventional explosives, directional explosives or small nuclear charges approximately at the circumference of the chimney or cavity expected and exploding these simultaneously or sequentially before, during and/or after the nuclear shock to create a cavity of desired shape which preferably will be substantially cylindrical. In one embodiment, the invention is applied to the enlargement and control of the shape of the desired cylindrical hole or cavity shot in oil shale thus to substantially enlarge the underground retort volume and amount of shale oil which can be recovered from a given formation area. In an embodiment described, the auxiliary explosives surround the expected cavity just outside its circumference. There are placed in the roof as well as at different levels across the cross-sectional area of the expected hole additional auxiliary explosives wherewith to control the roof configuration and to further enlarge the cavity, if needed. Sequential drilling and exploding of a series of charges, especially in the area of the top of the cavity, is disclosed. (Official Gazette)

11911 MOLECULAR-KINETIC MODEL OF RADIOACTIVE PARTICLE FORMATION PRODUCED BY SURFACE NUCLEAR EXPLOSIONS. Krasilov, G. A.; Ter-Saakov, A. A. At. Energ. (USSR); 31: No. 6, 581-4(Dec 1971). (In Russian).

A transient molecular-kinetic model of radioactive particle formation produced by surface nuclear explosions is suggested. The model is based on non-equilibrium of interaction between radioactive explosion products and ground material. As particles of underlying ground melted in the fire ball and radioactive explosion products in a vapor form are the subject of the investigation, the radioactive isotope distribution mechanism in soil particles was considered within the limits of the problem on transient interaction of vapor with fluid. Radioisotope penetration in the melted soil particles was determined by diffusive transport. Equations were derived to estimate both ground particle activity and activity distribution in their volume. (10 references) (auth)

11912 EXTENDING THE NUCLEAR-TEST BAN. Myers, Henry R. Sci. Amer.; 226: No. 1, 13-23(Jan 1972).

The significance of a nuclear test ban treaty to terminating the strategic arms race, and the traditional preoccupation of treaty negotiators, particularly the US, with methods for assuring that violations of bomb-testing agreements can be detected are discussed. Such methods include the use of space satellites for identifying craters from underground nuclear explosions and greatly improved seismic methods for distinguishing between underground nuclear explosions and earthquakes. The development and current status of the seismic methods are presented in detail. It is concluded that with presently available seismic techniques any underground nuclear explosion can be detected, and that insistence on on-site inspection as part of a nuclear test ban treaty is no longer a valid reason for postponing agreement to such a treaty. (L.C.L.)

11913 BENEFICIATION OF GEOLOGICAL FORMATIONS BY MEANS OF UNDERGROUND NUCLEAR DETONATIONS AND THE UTILIZATION OF WATER IN CONJUNCTION THEREWITH. Dixon, Rod P. (to American Oil Shale Corp.). U. S. Patent 3,608,636. 28 Sep 1971. Filed 30 Jan 1969.

When a nuclear explosive device is detonated underground in a geological formation, an extraneous liquid such as water is introduced into the resulting fragmented area of the formation to upgrade the quality of fluid products withdrawn therefrom. For instance, water introduced into a chimney formed by underground nuclear detonation in a natural gas field may be used to remove water soluble radioactive contaminants from the gas to be produced from the formation. In another embodiment, the radioactivity of a water supply which is to be accumulated underground in a nuclearly detonated reservoir may be reduced to an acceptable level by introducing an initial volume of water into the fragmented formation about and above the point of detonation in an early stage of the accumulation process such that this water would scrub radioactive contaminants from the detonated formation and the contaminated water consequently accumulating in such early stage following detonation is removed before accumulation of substantially pure water is begun. (Official Gazette)

11914 COMPREHENSIVE BAN ON NUCLEAR TESTING. Neild, Robert (Cambridge Univ., Eng.); Ruina, J. P. Science; 175: No. 4018, 140-6(14 Jan 1972).

The range of political, technical, and military issues involved in the consideration of a comprehensive test ban (CTB) treaty is reviewed and the decade of debate over these issues discussed. It is concluded that: seismic and other technical means of detecting and identifying underground nuclear explosions are now available which make on-site inspection for verification unnecessary and therefore no longer a valid reason for the US to refuse to join in a CTB; the CTB will have little effect on the arms race since it concerns only detonation and not nuclear weapons production or deployment (this, in turn, makes the CTB more acceptable to both nonnuclear and near-nuclear powers); peaceful uses of underground nuclear explosions do not now show great promise for economic development and instituting a CTB for a period of several years with later agreements on peaceful uses will have little economic significance; and the chief merits of a CTB are its political effects, i.e., as a demonstration by the big nuclear powers of sincere interest in future arms control. (L.C.L.)

11915 ENGINEERING WITH NUCLEAR EXPLOSIVES: ACHIEVEMENTS AND PROSPECTS. Parker, K. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Inst. Nucl. Eng.; 12: No. 6, 155-62(Nov-Dec 1971).

A chronology of events of engineering with nuclear explosives from 1945 to 1971 and forecasts for such events in 1972 and 1973 are tabulated. The engineering potentialities of nuclear explosives in general are discussed. The United States Plowshare program including proven applications, those at development stage, and those which have received serious study, and also the Soviet Union's program on nuclear explosives for the national economy are reviewed. The international aspects of the problem, the safety difficulties and economic considerations are discussed. (UK)

Facilities and Equipment

Refer also to abstracts 11979, 12010, 12299, and 14331.

11916 (BARC–555) SET-UP FOR STUDYING ISOTHERMAL AND ISOCHRONAL ANNEALING AFTER COLD WORK AND IRRADIATION OF METALS. Pande, B. M.; Anand, M. S.; Agarwala, R. P. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 13p. Dep. NTIS (U. S. Sales Only).

A system for studying isothermal and isochronal annealing of defects introduced in easily oxidizable metals by cold work or irradiation is described. It was standardized by studying the isochronal annealing of cold-worked molybdenum; various annealing stages are discussed. (auth)

11917 IRRADIATION LOOP WITH A CIRCULATING GAS. Marin, Francois (to Commissariat a l'Energie Atomique). French Patent 2,060,202. 18 Jun 1971. Filed 12 Sep 1969. (In French).

An irradiation loop for testing and controlling the behavior of fuel elements under conditions resembling those found in a reactor core, is presented. The loop allows very high temperatures to be obtained around the fuel elements, the gas circulating in the loop being preferably He. An annular canning is mounted inside an envelope with a metallic exterior; it defines a space in which the fuel element to be tested is placed. An exchanger recuperator device is situated above the fuel element. The circulating gas is heated during its passage through the exchanger-recuperator before it comes into contact with the fuel element; it then passes a second time through the exchanger-recuperator. (France)

11918 IMPROVEMENTS IN HEAT EXCHANGERS. Craig, Hugh Robert Morton; Jones, Norman (to Associated Electrical Industries Ltd.). British Patent 1,250,114. 20 Oct 1971. Filed 18 Feb 1969.

The heat exchanger described is stated to be suitable for installation in reactor chambers of limited diameter and relatively large vertical height. Arrays of heat transfer units are provided, each unit comprising spaced capillary tubes of bore diameter not greater than 0.125 inch. The units of an array extend radially from a common manifold, and the flow paths for one fluid communicate with this manifold through the tubes of all the units of the array,

and the flow paths for the other fluid extend in parallel through the spaces between the tubes of all the units of the array. The arrays will normally be arranged one above another. Both fluids may be gases or one fluid may be a gas and the other a liquid. Each heat transfer unit may comprise a number of capillary tubes extending between tube plates, together with a sleeve surrounding the tubes and defining a passage that extends between the end portions of the unit via the spaces between the tubes. (UK)

11919 CLOSURE MECHANISM. Curry, George G.; Dresser, John C.; Moeller, James A. (to United States Atomic Energy Commission). U. S. Patent 3,605,777. 20 Sep 1971. Filed 11 May 1970.

An apparatus is described for rapidly closing a conduit by pinching off with an explosive utilizing a tapered explosive collar about a tapering wall with a tamper for directing explosive energy against the tapering wall, and simultaneously igniting the explosive collar about its circumference. (Official Gazette)

11920 PRODUCTION OF EXPERIMENTALLY LABELLED AEROSOLS IN THE SUB-MICRON RANGE. Waite, D. A.; Ramsden, D. (Atomic Energy Establishment, Winfrith, Eng.). J. Aerosol Sci.; 2: No. 41, 425-36(Dec 1971).

An apparatus for the production of labelled, stable, insoluble particles of ferric oxide in the size range 0.08 to 0.5 μ is described. The apparatus has a high overall efficiency, and is very suitable for cases when the amount of material to be nebulized is limited. The characteristics of the particles are examined and the rapid variation of particle density with particle size is studied and explained on a simple semi-empirical theory. (auth)

11921 FLUIDIC EQUIPMENT FOR THE ENGINEERING PROTECTION OF A RADIATION LOOP USED FOR TESTING NUCLEAR FUELS. Florea, S.; Dumitrache, I.; Gaburici, V.; Ciocanescu, M. Automat. Electron.; 15: No. 5, 218-23(Sep-Oct 1971). (In Rumanian).

A protective system was developed to ensure the safe operation of a test loop in a reactor in cases involving a sudden increase of the fuel temperature caused by interference with the flow of the coolant gas. The studies revealed that the Coanda effect presents the most advantages for developing reliable pneumatic components for the protective system. Five stable elements were used as memory devices to store the signals received from the transducers in the detection and signaling block. Before it was used, the equipment was tested for a period of 200 hours. In order to simplify the design, the same active fluidic units were used to fulfill NOT and OR logical functions. (JPRS)

11922 DEVICE EMITTING RADIOACTIVE RADIATION. (to Societe Industrielle de Combustible Nucleaire). French Patent 2,054,740. 13 Apr 1971. Filed 24 Jul 1969. (In French).

A device in which a radioactive source is placed within a shielding, which absorbs entirely the radiation emitted everywhere except at a narrow slit controlled by a movable shutter, is described. The shielding consists of a block of metal in the form of a parallelepiped containing a vertical bore, which receives the pellet of radioactive material, and a second vertical bore accommodating the bush-type shutter, which is controlled externally, and a narrow vertical slit connecting the cavity with the second bore and extending beyond this bore in the wall of the block, thus directing the beam outside the block in a linear vertical form. The block is supported by an accurate positioning system, which allows its height and angular position to be controlled. (France)

11923 RADIOMETRIC SEPARATOR RRVP-01 AND ITS APPLICATION IN ORE-DRESSING PLANTS. Adamec, V. (Czechoslovak Uranium Industry, Kamenna). Rudy (Prague); 17: No. 9, 266-8(Sep 1969). (In Czech).

A brief description is given of a radiometric separator RRVP-01, designed for the separation of ores with natural radioactivity. It is composed of a hopper for mined ore, a vibratory feeder, a scanning feeder, a detection unit, a separator vessel, a separator element and its drive, and an evaluation electronic device. Technological parameters of this installation and its application in ore-dressing plants are given. (NSA of Czech)

11924 FINNATOM LOOP TEST RIG. Jafs, D. (A. Ahlstrom Osakeyhtio, Helsinki). Nucl. Eng. Int.; 16: No. 187, 1008-9(Dec 1971).

A hot loop suitable for full scale testing of primary circulators for water reactors, shortly to be commissioned in Finland, is described. (auth)

11925 PERIPHERAL SCANNING SYSTEM. Gaal, Andrew E. (to United States Atomic Energy Commission). U. S. Patent 3,597,849. 10 Aug 1971. Filed 12 Aug 1969.

A peripheral scanning system for measuring the surface shape of a rod is described. A pair of needlelike probes are maintained in contact with the outer surface of the rod while a mechanism is employed to maintain contact with the probes as the latter are moved transversely. Thus, the probes are forced to retract to accommodate changes in surface shape. Transducers are utilized to continuously report the positions of the probes. A swing arm arrangement interconnects the probes for simultaneous movement. (Official Gazette)

11926 CORRUGATED PLATE-TYPE STEAM SEPARATORS FOR NUCLEAR POWER GENERATION TURBINES. Hisano, Katsukuni (Hitachi Ltd., Ibaraki, Japan); Uenishi, Akira. Karyoku Hatsuden; 22: No. 6, 637-47(Jun 1971). (In Japanese).

Turbines for nuclear power generation must be able to remove moisture effectively, because steam obtained from reactors being planned and constructed at many places is of much lower quality than that of fossil fuel power stations in respect to both pressure and temperature, and produces a large quantity of moisture in the course of expansion in the turbines. The development, from the basic research stage to application, including trial manufacture and experiment, of corrugated plate-type steam separators for use in large-capacity turbines for nuclear power generation is described. Adoption of steam-water separating blades with grooves is one of the methods to remove the moisture. It is fairly effective, but still insufficient. It is necessary to install certain effective steam separators between high-pressure turbines and low-pressure turbines to obtain about 15% moisture at outlet stage of the low-pressure turbines. The corrugated plate-type steam separators were selected as the most practical among several types of steam separators, since the structure is comparatively well-known, performance is stable, and it is employed for steam separation at the outlet of reactors. Initially, characteristics of droplet distribution in the turbines was measured with special equipment. Then trial production of both high-pressure and low-pressure steam separators was carried out and performance was tested. A low-pressure corrugated plate-type steam separator was made for a 139 MW turbine for nuclear power generation in Pakistan. High-pressure separators are planned for 500 MW stations in Japan. (Japan)

11927 ^{60}Co 35kCi IRRADIATION FACILITIES. Koshino, Masao; Imai, Hisao; Masuda, Hiroyuki; Kaminishi, Tokishi; Nunome, Keichi (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku; 20: No. 2, 33-83(Feb 1971). (In Japanese).

The ^{60}Co 35 kCi irradiation facilities in this institute and characteristics of radiation are described. The building has the total floor space of 530 m^2, of which the irradiation and service area occupies 340 m^2. Two caves are located in the center of the service area. Shielding slabs of the caves are built of heavy concrete, the density of which is about 3.9 and the thickness is 1.3 m. The cylindrical cage is formed with 36 pencil-type sources. Each pencil, the shell of which consists of double capsules made of stainless steel, contains a number of pellets of radioactive cobalt. For end correction of dose distribution in the source cage, pellets of 25 Ci/g and 100 Ci/g were employed. The total activity of the ^{60}Co source was 35.1 kCi on Jan. 15, 1966. One dry-type and one wet-type source container are installed in each cave. One of the dry-type source containers is only for storage, the others are used as irradiation equipment for routine exposure. Employing a cage of 12 cm diameter, the exposure dose rate was 5×10^6 R/hr at the center inside the cage and 1×10^6, 1×10^5 and 1×10^4 R/hr at the distance 0.175, 0.57 and 1.9 m from the center of the cage, respectively. The distribution of the dose rate along the center line of the cylindrical cage (within the length of 18 cm) was satisfactorily uniform within ±5%. The leakage of gamma-radiation has been lowered to the order of from 10^{-1} to 10^{-2} of the legal dose by improvements over several times. Radiation protection was designed so that the exposure of the source cannot coincide with the opening of the door by the following three ways: master key handling by which most equipment can be ready to operate; interlocking mechanism among equipment by means of mechanical, electrical and radiation monitoring methods, and several mechanisms operating only under manual handling. Furthermore, several devices have been invented for preventing both the mechanical damage of the source and the radioactive contamination. (auth) (Japan)

11928 WATER REACTOR CIRCULATING PUMPS. Webster, G. R. (Hayward Tyler and Co. Ltd., Luton, Eng.). Nucl. Eng. Int.; 16: No. 187, 993-6(Dec 1971).

The evolution in pump design for water reactors is discussed. Canned motors used in early PWRs and wet stator motors as used in SGHWR are described and their advantages and disadvantages compared. Problems overcome in the establishment of glanded pumps for use in larger reactor units include the development of

suitable seals and special pump casings. Some recent developments in glandless pumps for BWRs, which are described, raise the possibility that these pumps may eventually be reintroduced for large reactors. (UK)

11929 CROYGENIC SOURCE OF NEGATIVE PIONS FOR CANCER THERAPY. Boyd, D.; Fairbank, W. M.; Schwettman, H. A.; Simpson, J. (Stanford Univ., Calif.). pp 104-22 of Helium Society. /Blizin, Jerald (comp.). Washington, D. C.; Helium Society (1971).

From Helium society symposium; Washington, D. C. (3 May 1971).

The use in cancer therapy of negative pions produced in superconducting electron accelerators with liquid helium as the cryogenic fluid is discussed. Facilities at the Stanford University Medical Center and the Los Alamos Meson Physics Facility are being used to conduct experiments which will result in actual pion therapy. The facilities and experiments are described. (L.C.L.)

11930 DESIGN, CONSTRUCTION, AND OPERATION FEATURES OF BLOWERS FOR STEAM GENERATING PLANTS. Honert, E. (August Thyssen-Huette AG, Duisburg, Ger.); Knuefer, H. Mitt. Ver. Grosskesselbetr.; 51: No. 1, 37-45(1971). (In German).

Developments in the design of blowers for conventional power stations are discussed. The principal components of the rotor-blade controlled blower and operational experience are described. In the second section the differences between gas circulators for gas-cooled reactors and boiler blowers are derived with the aid of physical and structural data. (INIS)

11931 IMPROVED COLD TRAP FOR SODIUM SYSTEMS. Roy, Prodyot; Pohl, Lawrence E. (General Electric Co., San Jose, Calif.). Nucl. Technol.; 13: No. 3, 284-8(Mar 1972).

High efficiency cold traps are desirable to reduce reactor sodium impurities to their lowest practical levels in order to minimize materials degradation and prevent system flow blockages from occurring. The trap efficiency can be improved by increasing the coefficient of mass transfer in the crystallizer zone, through increasing the turbulence in that region. A highly effective method of accomplishing this, utilizing electromagnetic stirring, was employed in sodium mass transfer studies at General Electric Company. The effect of increasing cold trap turbulence, to achieve calculated Reynolds numbers of up to 10^5, was tested in a loop by measuring hydrogen and oxygen removal rates with the cold trap operated in both turbulent and laminar modes. The results show that electromagnetic stirring increased the conventional cold trap efficiency from approximately 51 to approximately 99%. Use of this concept permits faster system impurity cleanup with smaller equipment than was possible heretofore. (auth)

11932 MEASUREMENT OF SIZE DISTRIBUTION IN AEROSOLS BY AN IMPACTOR. Bad'in, V. I.; Moiseev, Yu. K.; Batova, Z. G. At. Energ. (USSR); 31: No. 5, 534-6(Nov 1971). (In Russian).

The problems of calibrating an impactor for non-active aerosols are discussed. Methods are offered for calculating the significant self-absorption of α-radiation in aerosol particles. The degree of dispersion of coarsely dispersed α-active aerosols was determined by a direct autoradiographic method and by an impactor, and the results are compared. (K.S.W.)

11933 THERMAL SHOCKS ON THE MODEL OF A GATE VALVE. Novak, Josef (National Research Inst. of Machine Design, Bechovice, Czech.). Jad. Energ.; 17: No. 12, 407-12 (Dec 1971). (In Czech).

The temperature of a model of a steel gate valve was measured in the case of thermal shock caused by carbon dioxide flowing through the valve. Only thermal shocks with temperature decreasing with time were realized. The gate valve is the part of the primary piping systems of the first Czechoslovak nuclear power station. The results are presented of a complementary hydrodynamic investigation of a two-dimensional model of the gate valve. These results are pictorially represented. It was concluded that the temperature of the downstream seat of a gate valve during shock decreases more rapidly than the temperature of the upstream seat, and the time variations of the temperatures of these seats are functions of the location of the measuring points and the magnitude of the thermal shock. The influence of the thermal shock on the downstream seat and also the pressure drop of the gate valve decrease substantially when a guide ring is inserted behind the gate in order to guide the stream of gas when the gate valve is open. Thermal shocks of about 60, 160 and 220°C were realized starting from temperatures of 150, 250 and 300°C. (auth)

11934 SEALING DEVICE. Blachere, Robert; Sauvage, Michel (to Commissariat a l'Energie Atomique). British Patent 1,253,153. 10 Nov 1971. Priority date 20 Nov 1968, France.

A leak-tight seal between two parts is described. In a preferred construction, a rigid support, provided with six grooves, is arranged in such a way that in one position of the support, each of the parts to be sealed is in contact with two of the seals in the grooves, and the space between these two seals in each case is open to a source of fluid under pressure while the two remaining end seals are free. The seals are inflatable and can be displaced with respect to the parts to be made leak-tight, thereby permitting the replacement of at least some of the seals while avoiding any interruption of leak-tightness. (J.R.D.)

11935 LIGHTWEIGHT MOLECULAR SIEVE SAMPLER FOR MEASURING STRATOSPHERIC ^{14}C. Ashenfelter, T. E. (Air Resources Labs., Silver Spring, Md.); Gray, J. Jr.; Sowl, R. E.; Svendsen, M.; Telegadas, K. J. Geophys. Res.; 77: No. 3, 412-19(20 Jan 1972).

A new sampler for the collection of atmospheric CO_2 by means of molecular sieve adsorption has been developed and flown on operational USAEC balloon flights over San Angelo, Texas, (31°N) at altitudes ranging from 21 to 37 km. The total weight of this sampler and molecular sieve material is approximately 30 kg. Depending on altitude, between 1 and 5 liters of CO_2, sufficient for accurate ^{14}C measurements, were collected on each mission. Based on 24 measurements in 1968 to 1970, the ^{14}C data indicate the upper stratosphere has small vertical gradients at 31°N. (auth)

11936 PROCESS AND APPARATUS FOR SEPARATING THE CORES OF CLAD ELEMENTS. (to ENI-l'Electro-Navale and Industrielle). British Patent 1,252,687. 10 Nov 1971. Priority date 10 Jul 1968, France.

A process is described for recovery of fuel in conductively clad fuel elements. The process comprises electrochemically cutting the cladding and flushing out the core using a single liquid under pressure as the cutting electrolyte and the flushing agent. The process and equipment are related generally to recovery of fuels and/or fission products from the element core. (J.R.D.)

Heat Transfer and Fluid Flow

Refer also to abstracts 11918, 11924, 11926, 11930, 11933, 12655, 13342, 13343, 13353, 13360, 13900, and 14588.

11937 (COO-1723-F) CRITICAL HEAT FLUX STUDIES IN POOL BOILING AND FORCED CONVECTION. Final Report. Balzhiser, Richard E.; Barry, Robert E.; Caswell, Bruce F.; Gahman, Robert L.; Kim, Kwan Y.; Lampert, William B. (Michigan Univ., Ann Arbor. Dept. of Chemical Engineering). Oct 1971. Contract AT(11-1)-1723. 71p. Dep. NTIS.

Heat transfer to sodium in forced convection flow was studied in an annular test section at heat fluxes up to 1,659,000 Btu/hr ft^2. Experiment failures prevented completion of the experimental program. Three runs were completed before burnout was experienced at the above flux. Stable boiling was observed from the bayonet surface at a heat flux of 1,120,000 Btu/hr ft^2. The temperature profile in boiling potassium near the surface of a bayonet heater was measured. The results were in agreement with the theoretical model developed which included a thermal transport component in addition to the latent heat contribution which the hydrodynamic theory predicts. (auth)

11938 (GA-10602) SHAPE: A COMPUTER PROGRAM TO CALCULATE SHAPE FACTORS FOR THE CAPTEM PROGRAM. Kearney, D. W. (Gulf General Atomic Co., San Diego, Calif.). 16 Apr 1971. Contract AT(04-3)-167. 24p. Dep. NTIS.

The computer program SHAPE, which calculates shape factors from RAT results to be used for the thermal model in the CAPTEM program is described. The shape factor is defined, and calculation equations are presented for the solid rings and gaps in fuel capsule irradiation test samples. The input format and arrangement for the program are explained and illustrated by means of a sample calculation. (auth)

11939 (NP-19040) SODIUM EDDY DIFFUSIVITY OF HEAT MEASUREMENTS IN A CIRCULAR DUCT. Sheriff, N.; O'Kane, D. J. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). [1970]. 21p. Dep. NTIS (U. S. Sales Only).

Measurements have been made of the eddy diffusivity of heat in a circular duct with turbulent sodium flow. The conventional method of making such measurements is to take temperature traverses across the fluid stream with a uniform heat flux at the duct wall. For measurements in the central region of the duct

this method has several disadvantages, and in the present study a different technique has been used. The method used involves the injection of a point source of heat co-axially with the center line of the duct and temperature traverses downstream of the source. From the temperature measurements the total diffusivity is evaluated and hence the eddy contribution can be calculated. The development of the technique is described and values of total diffusivity measured at a Reynolds number of 8×10^4 are given in detail. A value for the ratio ϵ_H/ϵ_M is evaluated. (auth)

11940 (RT/ING-(70)28) POST BURNOUT HEAT TRANSFER AND THERMODYNAMIC DISEQUILIBRIUM UP TO THE CRITICAL PRESSURE. Cumo, M.; Farello, G. E.; Ferrari, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 4 Jan 1971. 22p. (CONF-700805-5). Dep. NTIS (U. S. Sales Only).

From fourth international heat transfer conference; Paris-Versailles, France (31 Aug 1970).

Experimental results are presented for the heat transfer coefficient in post-burnout conditions up to the critical pressure with Freon 12 flowing upward in tubular, uniformly heated ducts. The heat transfer coefficient and the degree of superheating were systematically tested against various leading parameters such as vapor quality, mass flowrate, and reduced pressure. The research provided results applicable to once-through heat exchangers, such as the steam generators in sodium-cooled fast reactor plants. (auth)

11941 TWO-PHASE CRITICAL FLOW OF ONE-COMPONENT MIXTURES IN NOZZLES, ORIFICES, AND SHORT TUBES. Henry, Robert E.; Fauske, Hans K. (Argonne National Lab., Ill.). J. Heat Transfer; 93: No. 2, 179-87(May 1971).

The critical flow of one-component, two-phase mixtures through convergent nozzles was investigated and discussed including considerations of the interphase heat, mass, and momentum transfer rates. Based on the experimental results of previous investigators, credible assumptions are made to approximate these interphase processes which lead to a transcendental expression for the critical pressure ratio as a function of the stagnation pressure and quality. A solution to this expression also yields a prediction for the critical flow rate. Based on the experimental results of single-phase compressible flow through orifices and short tubes, the two-phase model is extended to include such geometries. The models are compared with steam-water, cryogenic, and alkali-metal experimental data. (auth)

11942 VOID FRACTION AND HEAT TRANSFER COEFFICIENT OF SODIUM-ARGON TWO-PHASE FLOW IN VERTICAL CHANNEL. Ochiai, Masaaki; Kuroyanagi, Toshiyuki; Kobayasi, Kiyosi; Furukawa, Kazuo. Nippon Genshiryoku Gakkaishi; 13: No. 10, 566-73(Oct 1971). (In Japanese).

The void fraction in a vertical upward two-phase flow of Na–Ar was measured using electro-magnetic flow meters and γ-ray attenuation. It was found that with a flow pattern of bubbly flow, the statistical error induced in measurements of void fraction was slightly greater when using γ-ray attenuation as compared to electro-magnetic flow meters, while with slug flow electro-magnetic flow meters method were quite incorrect. Measurements were also made on the heat transfer coefficient of Na–Ar two-phase flow with uniform heat flux. The addition of a small quantity of the injected Ar decreased the heat transfer coefficient, but upon further increase of the gas content the coefficient increased after passing a minimum value. (auth)

11943 DYNAMIC EFFECTS IN RADIATION DIAGNOSIS OF FLUCTUATING VOIDS. Harms, A. A. (McMaster Univ., Hamilton, Ont.); Forrest, C. F. Nucl. Sci. Eng.; 46: No. 3, 408-13(Dec 1971).

The factors contributing to the bias introduced in the experimental determination of void fractions in liquid flow systems by methods of radiation diagnosis are being examined. It is shown that error bounds for the radiation transmittance and for the void fraction can be established for certain well-defined void variations. The general validity of the analytical results has been experimentally tested and confirmed. In addition, analytical criteria are derived which relate radiation attenuation and certain parameters of the radiation diagnostic facility to the dynamic voiding effects. (auth)

11944 THEORETICAL STUDY OF TWO-PHASE FLOW OSCILLATION IN A HOT CHANNEL. II. INFLUENCE OF HEAT TRANSFER CHARACTERISTICS ON THE FLOW STABILITY. Takahashi, Ryoichi; Shindo, Masuo (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 12, 690-5(Dec 1971).

The kinetic behavior of two-phase flow is considered by conventional linear control theory. This study considers only the essential factors so as to simplify the interpretation of the mechanisms involved in the observed phenomena. A change in heat flux due to a change in coolant velocity is taken into account to study the influence of heat transfer characteristics on the flow stability. While this influence has not appeared as clearly as in the previous numerical experiment, agreement with measurements was obtained. (auth)

11945 PROPAGATION OF PRESSURE WAVE IN AIR-WATER TWO-PHASE SYSTEM. II. Miyazaki, Keiji; Fujii-e, Yoichi; Suita, Tokuo (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 12, 673-81(Dec 1971).

Trends observed in the experimental data of increasing deviation of pressure wave velocity from the nonslip homogeneous model are explained from consideration of slip between the phases. The slip reduces the inertial effect of liquid and consequently brings about an increase in the wave propagation velocity. In order to testify quantitatively to the above interpretation by analysis of observed data, the theoretical approaches of perturbation method and Fourier transformation in time and space were applied to the fundamental equations of mass and momentum of each phase, taking the interaction between the phases as a function of the relative velocity only. The propagation velocities dependent on frequency were calculated from the characteristic equation derived by the above procedure, and fairly good agreement was obtained between theoretical and experimental data arranged with frequency as parameter. Applicability of linearization theory and relaxation of shock formation are discussed, and they are attributed also to attenuation effect by slip. (auth)

11946 MINIMUM THICKNESS OF A DRAINING LIQUID FILM. Bankoff, S. George (Argonne National Lab., Ill.). Int. J. Heat Mass Transfer; 14: No. 12, 2143-6(Dec 1971).

The formation of dry spots in a draining liquid film is important in relation to the rate of expulsion of Na from coolant channels after a fast reactor accident. An analysis is therefore made of the short-time stability of thin heated films on vertical walls. The Hartley–Murgatroyd energy criteria is employed in a context which allows surface wettability to be taken into account. Minimum stable film thicknesses are calculated for Na, Freon 113, and H_2O. It is concluded that a well-wetted wall will probably maintain an unbroken film in contact with it during at least the early expulsion period. (UK)

11947 CALCULATION OF THE VELOCITY FIELDS AND THE COEFFICIENT OF TURBULENT CONDUCTIVITY IN CHANNELS OF COMPLEX FORM. Buleev, N. I. (Obninsk Physics and Power Inst., USSR). High Temp. (USSR) (Engl. Transl.); 9: No. 2, 407-10(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 445-8(Mar-Apr 1971).

In order to calculate the temperature fields in a fluid flowing around a fuel element in a reactor, calculations were first made on the energy equation into which enter the hydrodynamic characteristics of the flow, i.e., the velocity of the motion of the fluid $w(x,y)$ and the coefficient of turbulent diffusivity, ϵ_H. For the sake of simplicity, it was assumed that the latter is not dependent on the direction. The agreement obtained for a specific grid of rods was sufficient for engineering calculations. (P.C.H.)

11948 VELOCITY DISTRIBUTION OF COOLANT FLOWING THROUGH THE RODS OF A FUEL ELEMENT PROTOTYPE FOR THERMAL CORES. Grillo, P.; Cerretti, P. L. (CNEN, Casaccia, Italy). Calore; 52: No. 1, 9-15(1971). (In Italian).

An analysis was made of turbulent flow in square lattice fuel element subchannels. Some experiments were performed on a 64-rod bundle in order to measure velocity distribution inside the subchannels. Experimental data are compared with those predicted by Von Karman relationships used for the analysis of turbulent and incompressible flow in circular tubes. (INIS)

11949 SURVEY OF NUCLEONIC HEAT TRANSFER RESEARCH AND DEVELOPMENT. HTD-VOL. 1. New York; American Society of Mechanical Engineers (1971). 42p. $5.00.

The results of a survey of 70 current (1969 to 1971) research and development projects dealing with nucleonic heat transfer are tabulated. Table I indicates the analytical or experimental nature of the investigation, the fluids used, subject investigated, and geometry or system of interest. Table II gives the following information: project title; name, affiliation, and address of persons in charge; date of information; objectives of project; description of the investigation; status of investigation as of date of information; anticipated completion date; and publications. (L.C.L.)

11950 TECHNIQUE FOR INTRODUCING LOW CONCENTRATIONS OF ADDITIVES TO HIGH PRESSURE GAS STREAMS.

Best, J. V. (Central Electricity Generating Board, Berkeley, Eng.). J. Phys., E (London); 4: No. 12, 1066-8(Dec 1971).

A technique is described for continuously adding low concentrations of additives to high pressure, low flow rate gas streams. The method utilizes the diffusion of gases and vapors through plastics and avoids the problems of mixing two gas streams at very low flow rates. It is shown to be successful in adding water vapor (0 to 1000 Vpm) to dry carbon dioxide and carbon dioxide (0 to 100 Vpm) to pure helium. (auth) (UK)

Isotope Technology

Refer also to abstracts 11827, 11833–11835, 11922, 11927, 11993, 12027, 12028, 12108, 12725, and 14108.

11951 (CONF-710402-(Vol.1)) NEUTRON SOURCES AND APPLICATIONS. Proceedings of the American Nuclear Society National Topical Meeting, Augusta, Georgia, April 19–21, 1971. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug 1971. Contract AT(07-2)-1. 326p. Dep. NTIS.

A separate abstract was prepared for each of the 30 papers included. (M.C.G.)

For abstracts of individual papers see: 11542–11544, 11952–11956, 11993, 12026–12028, 12197–12199, 12206, 12361–12366, 12389, 13115, 13389, 13840, 13919, 13920, 14515, and 14516.

11952 (CONF-710402-(Vol.1), pp I.29-51) RECENT DEVELOPMENTS IN RADIOISOTOPE NEUTRON SOURCES. Tolmie, R. W. (Atomic Energy of Canada Ltd., Ottawa (Ontario)). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

At the present time there are about 20 radioisotopes from which neutron sources are made. (α,n) sources like ^{241}Am: Be and ^{238}Pu: Be are widely used in instruments and in other applications which require low output, long-lived sources. ^{227}Ac, ^{210}Po, ^{228}Th, and ^{242}Cm: Be are available for higher output needs. Physically small fast neutron sources can be economically made from ^{252}Cf fission sources, whereas the (γ,n) source ^{124}Sb: Be is more suitable for physically large, very high output thermal neutron sources. The (γ,n) sources and some special (α,n) source designs provide for switching the neutron output off and on. Encapsulation problems and other sources that might be used in the future are discussed. (auth)

11953 (CONF-710402-(Vol.1), pp I.85-100) NEUTRON SOURCES: A LOOK TO THE FUTURE. Panel Discussion. Beyster, J. R.; Berger, H.; Caswell, R. S.; Claiborne, H. C.; Morgan, I. L.; Tolmie, R. W.; Whittemore, W. L. Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

A panel discussion of neutron sources, both radioisotope and accelerator, is presented. Information is included on: uses for radiography, well logging, and analytical analysis; characteristics and performance; production; encapsulation; costs; transport; shielding; and safety. (L.C.L.)

11954 (CONF-710402-(Vol.1), pp IV.1-19) INDUSTRIAL USES OF NEUTRONS FOR PROCESS AND QUALITY CONTROL. Stone, Leonard R. (Republic Steel Corp., Cleveland, Ohio). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

A brief review is presented of neutron uses in industry — past, present, and future uses involving reactor, accelerator, and isotopic neutron sources. The past uses of the sources are reviewed in terms of generalized graphs characterizing the author's impressions of relative industrial use of neutrons for process and quality control from 1955 to 1970. Specific uses in Republic Steel over this same period are also tabulated. The current and developing industrial uses of neutron sources are reported via summaries of technical papers submitted for review — five relating to isotopic sources, one to accelerators, and none to reactor sources. As to future uses, projected growth curves from 1970 to 1975 are presented for each of the three source types. For important specific future uses of these sources, the following items are suggested as areas of challenge and promise: on-stream composition analysis, product fingerprinting, short half-life radioisotopes, product sorting and transport control, routine laboratory analysis, material irradiation studies, specialized energy sources, nuclear weighing of molten metals, and non-contact temperature measurement. (auth)

11955 (CONF-710402-(Vol.1), pp IV.21-37) SOURCES FOR INDUSTRIAL NEUTRON RADIOGRAPHY. Barton, John P. (Argonne National Lab., Ill.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The state of the art concerning neutron sources for industrial neutron radiography is surveyed. Papers submitted from the Commissariat a L'Energie Atomique, France, University of Birmingham, England, Gulf General Atomic, Battelle Memorial Institute, General Dynamics, and University of Texas are summarized. The applications discussed originate from the nuclear, aerospace, and ordnance industries, but a number of general research and development applications in materials science are also described. The survey gives details of five new reactors now available for neutron radiography. These are a pulsed reactor based on uranyl nitrate solution, a 10 kW steady power reactor based on uranyl sulfate solution, a 5 kW pool reactor based on 5-mm diameter uranium-alloy fuel pins, a 100 kW pool reactor based on MRT-type uranium-alloy fuel plates, and a 100 kW uranium–zirconium hydride reactor. Also, application work is described that is based on deuteron–tritium type generators, Van de Graaff machines, and linear accelerators. Reference is made to neutron radiography tests using seven types of isotopic source. For source yields in the range 10^9 n/sec to 10^{10} n/sec, particular attention is devoted to ^{252}Cf. (auth)

11956 (CONF-710402-(Vol.1), pp V.1-6) ACTINIUM–BERYLIUM NEUTRON SOURCES. De Troyer, A.; Droissart, A.; Poskin, M. (Union Miniere S. A., Brussels (Belgium)). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Notwithstanding their interesting characteristics $Ac(\alpha,n)Be$ neutron sources have not received practical attention so far. The reason is that ^{227}Ac was a rather exotic isotope which was only available in very small quantities at very high prices. A production of large quantities having been started for some time now, the situation has changed completely and a large scale use of Ac–Be sources can now be envisaged. To this effect, a program of production was initiated in combination with the experimental determination of the principal characteristics of these sources. Special attention has been paid to obtaining a high neutron output per unit weight of actinium, the price per neutron being of importance in the choice of a neutron source for industrial applications. A comparison of the characteristics of Ac–Be sources with other currently used radioisotopic neutron sources shows the interest of the former. (auth)

11957 (GEMS-NS-107) ADVANCED SPACE RADIOISOTOPE THERMOELECTRIC POWER SUPPLY STUDY. Final Technical Report. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Aug 1964. Contract AT(30-1)-3391. 226p. Dep. NTIS.

A preliminary design is presented of a ^{90}Sr-fueled thermoelectric generator, and a conceptual design of a fuel handling system, based on technology used on SNAP-17B. The primary characteristics of the generator and handling apparatus are tabulated. The 250-W(e) generator is designed to operate at 28 ± 10% V for five years at an overall efficiency of 4.9%. (J.R.D.)

11958 (LA-4759) ICONS AT LASL: A PROPOSAL TO THE AEC DIVISION OF BIOLOGY AND MEDICINE FOR THE PRODUCTION AND USE OF SEPARATED ISOTOPES OF CARBON, OXYGEN, NITROGEN, AND SULFUR. Schreiber, R. E. (ed.) (Los Alamos Scientific Lab., N. Mex.). Sep 1971. Contract W-7405-eng-36. 18p. Dep. NTIS.

A plan to augment the capabilities of LASL in the separation and use of stable isotopes of C, O, N, and S (ICONS) is discussed. The broad objective of the program is to carry through an assessment of the potential of ICONS in a wide variety of fields that include basic chemistry, biology, medicine, agriculture, environmental improvement, and, in general, any area in which the ability to trace a material containing carbon, oxygen, or nitrogen is of value. Since the ICONS are stable, many applications can be made in which there would be both technical and political problems in using radioactive tracers. The hope is that the program will be executed with sufficient scope to identify the true potential of this new capability but still be executed within a reasonable time and cost. (J.R.D.)

11959 (ORNL-TM-3621) ISOTOPE PROGRAM (5000) PROGRESS REPORT FOR QUARTER ENDING SEPTEMBER 30, 1971. Gillette, J. H. (Oak Ridge National Lab., Tenn.). Nov 1971. Contract W-7405-eng-26. 17p. Dep. NTIS.

Research and development progress is reported in sections on target fabrication and development, isotopic separations, 180°

sector isotope separator, chemical processing and isotope preparation and sales. (J.R.D.)

11960 (RISO–248) STUDIES ON TRANSPORT OF MASS AND ENERGY IN THE VORTEX TUBE. THE SIGNIFICANCE OF THE SECONDARY FLOW AND ITS INTERACTION WITH THE TANGENTIAL VELOCITY DISTRIBUTION. Linderstroem-Lang, C. U. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sep 1971. 117p. Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Copenhagen Univ., Denmark.

The properties of the Ranque–Hilsch tube and related vortex tubes are reviewed. A unified description is attempted based on the literature available; special emphasis is, however, put on previous contributions by the author. A qualitative discussion is included on the characteristic temperature and concentration differences created between the two product streams. Also included are discussions on the interaction between rotational motion and secondary flow, and on the distribution of concentration and temperature within the tubes. Two-dimensional approximations, neglecting axial changes, are also discussed. A three-dimensional treatment is, however, essential for the understanding of the functioning of tubes working under optimum conditions, therefore the emphasis is put on three-dimensional theories and their quantitative interpretation. Two aspects, e.g., separative work (for mass separation) and availability (for energy separation) are related to the flow dynamics of the tubes. The equivalence of the two functions is established and the relation between mass and energy separation is discussed. The performance of the tube in its two capacities is related to that of other devices with similar functions, such as gas centrifuges and nozzle separators (in the case of mass separations) and cooling machines (in the case of energy separation). (auth) (Denmark)

11961 (TID–21015(Rev.3)) INTERPOLATED VALUES FOR THE SCHEDULE OF BASE CHARGES AND THE STANDARD TABLE OF ENRICHING SERVICES. (Oak Ridge Operations Office (AEC), Tenn. Production Div.). Aug 1971. 245p. Dep. NTIS.

The United States Atomic Energy Commission (AEC) published in Federal Register Notice 36 FR 4563 dated March 9, 1971, a revised schedule of base charges for uranium as UF_6 to be effective September 6, 1971. The schedule of base charges, which is composed of normal uranium feed and separative work charges at unit (kilogram) charges of $23.46 and $32, respectively, is applicable to uranium as UF_6 sold or leased by the AEC. The standard table of enriching services, which lists the units of feed and separative work required per unit of product, published by the AEC in Federal Register Notice 32 FR 16289 dated November 29, 1967, remains in effect for uranium as UF_6 obtained through toll enriching contracts with the AEC. The units of feed and separative work per unit of product are based on an enriching services tails assay of 0.20 weight percent ^{235}U. The base charges and the enriching services feed and separative work units listed in the referenced Federal Register Notices are for assay increments which vary from 0.02 to 10.00 weight percent ^{235}U. This report has been prepared to supplement the Federal Register Notices by publishing interpolated values to the nearest 0.01 weight percent ^{235}U assay using the Federal Register values (denoted in this report by asterisks to the left of the respective assays) as the reference values. (auth)

11962 (WANL–543–4) ^{60}Co HEAT SOURCE DEMONSTRATION PROGRAM, PHASE II. FINAL REPORT. DETAIL DESIGN. Sadler, John W. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). May 1971. Contract AT(38-1)-543. 238p. Dep. NTIS.

Activities directed toward design and testing of a ^{60}Co heat source and development of supporting hardware are summarized. Research and development progress is described on demonstration heat source, fueling cask, shipping container, and demonstration test loop. (J.R.D.)

11963 (WANL–3800-42) PHASE 1, PRELIMINARY SAFETY ANALYSIS REPORT. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Feb 1970. Contract AT(30-1)-3800. 385p. (WANL-PR-SS–5). Dep. NTIS.

Analytical studies were made to determine the response of the SNAP-23A system to 1475 and 1850°F one half-hour fires. Results of the studies showed that the post-fire converter conductance has a major effect in determining whether the steady state temperatures achieved following the fire will result in fuel capsule and shield integrity. Converter tests in a simulated fire environment were used to demonstrate that converter conductance is not adversely affected as a result of either fire. This test result, combined with results of analytical studies, indicates that the system alone can meet safety criteria. That is, post-fire steady state temperatures will be within acceptable limits without engineered safeguards or artificial cooling. The system shipping container will provide additional protection from the fire environment during transport. Siting problems and hazards have been investigated. The general scope of siting accidents can be related directly to the detailed accident analyses contained in this report. Other than earth burial, siting poses no specific safety problem. If burial in a very low conductivity soil is a potential hazard (and this is doubtful) then simple engineered safeguards can be used. With one exception, the safety criteria evolved at the start of the program still appear to be attainable design standards. A thorough survey of the explosion-overpressure accident environment has indicated that the original criterion was unrealistic. The overpressure accident model defined in this report is based on conditions at 30 feet from a tank truck with a two percent equivalent TNT yield explosion. (auth)

11964 INVESTIGATION OF STUFF FLOW IN DUMP PITS OF PAPER MILLS BY MEANS OF LABELLING TECHNIQUE. Balla, B.; Fejes, P.; Kalman, L.; Sarkany, A. (Inst. for Isotope, Budapest). Isotopenpraxis; 7: No. 6, 224-6(Jun 1971). (In German).

The pulp characteristic in a Hungarian paper-mill was investigated. ^{198}Au applied to the cellulose fibres by means of chemical reduction was used as indicator. The measured values were evaluated by means of an electronic computer. Previous works of Bischoff and Levenspiel rendered possible calculation of the values of radial and axial dispersion. Correlations between dispersion and paper quality being unknown, empirical methods have to be applied to fix the optimum flow characteristic, while dispersion serves to determine deviations from the optimum conditions. (auth)

11965 ELECTROMAGNETIC SEPARATION OF ISOTOPES OF THE PLATINUM–PALLADIUM GROUP. Bochin, V. P.; Gavrilov, B. E.; Zolotarev, V. S. Isotopenpraxis; 7: No. 6, 232-5(Jun 1971). (In Russian).

A newly developed technique for fluorination of the corresponding metals in the crucible of a standard ion source was applied in an electromagnetic separator to separate platinum, iridium, and ruthenium isotopes. Thus the efficiency of the separating plant was increased by several tens of times, compared with the method of separation in high-temperature ion sources. The quality of separated isotopes with regard to their enrichment and chemical purity also by far surpassed the one obtained with the use of high-temperature equipment. (auth)

11966 CURIE MEASUREMENT OF ^{60}Co SOURCE BY $^{9}Be(\gamma,n)$ REACTION. Fujishiro, Masatoshi; Furuta, Junichiro. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 111-14(1970).

The curies of a ^{60}Co source were measured directly using the $^{9}Be(\gamma,n)$ reaction. Wolfson's branching ratio $(1.2 \pm 0.2) \times 10^{-3}\%$ and Dixon's branching ratio $0.7 \times 10^{-3}\%$, and Jakobson's cross section were used for the calculation of the curies. The results thus measured were $\frac{1}{2} \sim \frac{1}{3}$ of the value estimated from usual exposure rate measurement by Radocon. The discrepancy might be explained by the errors of the neutron counting rate, and of the branching ratios and the cross section used. (auth)

11967 DETERMINATION OF THE WEAR OF MACHINE PARTS BY CHARGED PARTICLE SURFACE ACTIVATION. Konstantinov, I. O.; Krasnov, N. N. (Inst. of Physics and Power Engineering, Obninsk, USSR). J. Radioanal. Chem.; 8: No. 2, 357-71(Aug 1971).

Surface activation with charged particles is a suitable method for determination of wear in machine parts. Investigations of the dependence of the yield of major radioactive isotopes on particle energy and of the distribution of these isotopes along the depth of the activated layer are reported. Activation and activity measurement conditions for common materials of construction are suggested. Calculation procedures for converting activity values into absolute wear data and for evaluating methodical errors are given. (auth)

11968 ON-LINE ISOTOPE SEPARATION. Jastrzebski, Jerzy (Instytut Badan Jadrowych, Swierk, Poland). Postepy Fiz.; 22: No. 4, 315-47(1971). (In Polish).

A description is given of the on-line isotope separation method for the study of nuclei far-off the beta stability line. The ISOL systems (isotope separator on-line) developed in different laboratories are reviewed. Some applications to the nuclear structure and nuclear reaction studies are presented. (auth)

11969 DEVELOPMENT OF ISOTOPE AND RADIATION TECHNIQUES IN THE GERMAN DEMOCRATIC REPUBLIC. Uhlig, K. (Ministerium fuer Grundstoffindustrie, Berlin). Isotopenpraxis; 7: No. 7, 251-6(Jul 1971).

A review of organization of isotope and radiation technologies in the GDR is presented along with information on activities of these organizations, development of radiation techniques, personnel training, and international cooperation in isotope and radiation technologies. (J.R.D.)

11970 SEALED SOURCES. SOME ASPECTS OF DEVELOPMENT AND PRODUCTION IN THE GERMAN DEMOCRATIC REPUBLIC. Vormum, G.; Schaefer, H. (Zentralinstitut fuer Isotopen- und Strahlentechnik, Berlin). Isotopenpraxis; 7: No. 7, 257-61(Jul 1971).

A review of international activities related to sealed sources is presented along with a description of these sources developed in the GDR. Information is also included on source testing and new developments related to radiation sources. (J.R.D.)

11971 TECHNOLOGY UTILIZATION IDEAS FOR THE 70's AND BEYOND. Proceedings of a Special AAS/AIAA Technical Event, Winrock, Arkansas, October 30, 1970. Forbes, F. W.; Dergarabedian, P. (eds.). AAS Science and Technology Series, Volume 26. Tarzana, Calif.; American Astronautical Society (1971). 328p. (CONF-701058).

Twenty-two papers on applications of aerospace technology to terrestrial problems were presented at the conference. A separate abstract was prepared for each of two papers. Twenty papers were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 11972 and 14457.

11972 ISOTOPE X-RAY DEVICE. Russell, D. R. (General Dynamics, Ft. Worth, Tex.). pp 193-5 of Technology Utilization Ideas for the 70's and Beyond. /Forbes, F. W. (ed.). Tarzana, Calif.; American Astronautical Society (1971).

From Conference on technology utilization ideas for the 70's and beyond; Winrock, Ark. (30 Oct 1970).

A non-electrical, multipurpose x-ray device which is small, lightweight, and portable is discussed. Areas of biomedical applicability are identified, and several characteristic radiographs obtained with the device are presented and discussed. (auth)

11973 THERMAL-ELECTRIC GENERATOR. (to Atomic Energy of Canada Ltd.). British Patent 1,257,250. 15 Dec 1971. Priority date 30 Sep 1969, Canada.

The design of a radioisotope electric power generator for the generation of electric power by means of the thermoelectric conversion of heat from radioisotope sources is described. (L.C.L.)

11974 GASEOUS DIFFUSION CASCADE UNIT. Anzai, Seinosuke; Nagasima, Yasuo; Siozawa, Sigeo (Sumitomo Shipbuilding and Machinery Co. Ltd., Tokyo). Sumitomo Jukikai Giho; 18: No. 51, 38-40(Dec 1970). (In Japanese).

The success achieved in the manufacture of the three stage cascade unit to be used in the experiment of uranium enrichment by gaseous diffusion is described. The objective of this experimental equipment is to ascertain the efficiency of the diffusion membrane, as well as to separate the uranium isotope with the use of the diffusion membrane. This experimental equipment has been delivered to The Institute of Physical and Chemical Research. (auth) (Japan)

11975 POSSIBLE APPLICATIONS OF TRANSURANIUM ELEMENTS. Mueller, Werner (EURATOM, Karlsruhe, Ger.). Chem. Ztg.; 95: No. 6, 285-92(1971). (In German).

Transuranium elements emit photons, x-rays, and neutrons; their interactions with matter are the basis for the application of these elements in science, medicine and technology. Gamma sources of ^{241}Am are used for radiography, for measuring thickness and concentrations, for producing x-ray fluorescence. Backscattering of α-particles and gas ionization produce mechanical energy in radionuclide batteries or thermal engines. Neutrons may be applied in analytical instruments. The α-decay heat can be converted into electric energy or in (α,n) reactions or by spontaneous fission may be used for irradiation (radiotherapy) and activation (radiodiagnosis, mineral prospection, or air pollution control). Neutron absorption and scattering are the basis for neutron radiography or the determination of light elements (e.g., in water or mineral oil). Among the examples cited, special emphasis is given to the application of ^{238}Pu in cardiac pacemakers and heart assist pumps as well as numerous possibilities for the use of portable ^{252}Cf sources. (INIS)

11976 PROBLEMS CONCERNING THE ELECTROSTATIC CHARGE DURING CONTINUOUS PRODUCTION AND PROCESSING OF PAPER-RUBBER-PLASTIC FOILS. Kraemer, H.; Messner, D. (Kalle AG, Wiesbaden, Ger.). Kunstst.-Rundsch.; No. 6, 265-71(1971). (In German).

The causes of electrostatic charges are discussed and interpreted for paper, rubber and plastics using the energy band model. A possibility of eliminating these charges is ionization by α-particles from ^{210}Po. (INIS)

11977 GENERAL. pp 5-61 of Radioisotope Production and Quality Control. Vienna; International Atomic Energy Agency (1971).

See STI/DOC-10/128.

A general review is presented of radioisotope uses in medicine, industry and agriculture, and scientific research, and includes tabulated data on specific uses of particular isotopes. Information is included on the consumption of radioisotopes, the estimated savings which have resulted from radioisotopes uses in industry, and the problems associated with local production of radioisotopes. (L.C.L.)

11978 PROPER HALF VALUE THICKNESS OF ALPHA EMITTERS. Zderadicka, J.; Plch, J.; Bucina, I. (Inst. for Research, Production, and Use of Radioisotopes, Prague). Radioisotopy; 11: No. 6, 997-1017(1970). (In Czech).

In connection with the preparation of standards for the semiconductor spectroscopy of alpha particles attention was paid to half-value-thickness determination of standards. The calculation of the proper half-value thickness of standards, based on the theory of alpha-particle interaction with matter, was experimentally verified by means of a set of emitters, which were prepared by vacuum sublimation of high-purity americium dioxide on highly polished stainless steel plates. Comparison of these emitters with electrolytically prepared EA standards for semiconductor spectrometry showed that there is no substantial difference in the proper half-value thickness between emitters prepared by these two different methods. Correlation was found between self-absorption and alpha-particle deformation; this may be used for the determination of self-absorption corrections in the calibration of alpha-emitting radionuclides. (auth)

11979 ULTRACENTRIFUGE ROTOR FOR ISOTOPIC SEPARATION. (to Societe Nationale Industrielle Aerospatiale). British Patent 1,259,255. 5 Jan 1972. Priority date 5 Sep 1969, France.

The design of a very long rotor for high-speed rotation in an ultracentrifuge for isotopic separation, such as the separation of ^{235}U from ^{238}U, is described. The rotor is constructed with an internal cylinder, an external cylinder, and a series of circumferentially distributed spacing members extending radially between the two cylinders. (L.C.L.)

11980 CARDIAC PACEMAKER. Alais, Michel Emile; Crampon, Edmond Charles Gustave; Aubin, Jean Rene; Fontaine, Marie (to Societe Alsacienne de Constructions Atomiques de Telecommunications et d'Electronique). French Patent 2,066,894. 13 Aug 1971. Filed 27 Oct 1969. (In French).

A self-operating implantable cardiac pacemaker is described. It consists of an energy source connected to an electrical circuit which delivers the stimuli: the source consists of a lower power radioactive element (Pu) and a thermoelectric element extracting the energy in the form of heat and converting it into an electrical potential (<1 volt). The energy source is connected directly to the electronic circuit and in this way produces a high energy yield. (France)

11981 THERMAL/ELECTRICAL ENERGY CONVERTOR. Lavigne, Pierre (to Commissariat a l'Energie Atomique). French Patent 2,068,093. 26 Jul 1971. Filed 27 Nov 1969. (In French).

A thermal/electrical energy converter was developed. It consists of a linear alternator (a fixed secondary within which an inductor moves linearly) and a driving machine operating with a fluid, which moves in a closed circuit. This machine consists of two parts, each possessing a piston connected directly to the inductor and communicating to it a to-and-fro motion. The motion of the pistons is simultaneously accompanied by an expansion of the fluid while absorbing the heat from the hot source and a compression when restoring the heat. An elastic system returns the pistons in the opposite sense. A heat exchanger is provided in which the hot fluid driven from the expansion chamber and the cold fluid from the compression chamber circulate in opposite directions in two circuits. These fluids are thus reintroduced into the compression and expansion parts. (France)

Materials Testing

Refer also to abstracts 11955, 12673, 12797, and 14225.

11982 (ANL–7831) APERTURE CURRENTS AND PROBE RESPONSES FROM ELECTROMAGNETIC TESTS. Cox, Cyrus W. (Argonne National Lab., Ill.). Aug 1971. Contract W-31-109-eng-38. 19p. Dep. NTIS.

A mathematical validation is presented for representing apertures and defects in conductors as current sources when excited by massive externally pulsed fields. The current distribution contributed by a cylindrical void in a conductor is derived, and the result is used to approximate the flux that links a pickup coil, the rim of which passes over an aperture. The concept of defect current is used to estimate the form of the response of a scanning mask-aperture probe passing over a defect. (auth)

11983 (ORNL–4714) POSTIRRADIATION EXAMINATION AND EVALUATION OF THE PERFORMANCE OF HFIR FUEL ELEMENTS. Richt, A. E.; Knight, R. W.; Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 92p. Dep. NTIS.

The results of the postirradiation examination and evaluation of the prior performance of four spent fuel elements from the High Flux Isotope Reactor are discussed. Two elements had been immersed in boiling deionized water for 24 hr before being operated for 2046 MWd. The other two were not pretreated and operated for slightly over 2300 MWd (the normal reactivity lifetime). These elements were examined to determine their overall condition and detect any unexpected problems that might compromise continued operation of the present fuel elements to their full reactivity lifetime. All four fuel elements were in excellent condition. Gamma scanning and analytical burnup determinations showed the time-integrated power and burnup distribution within these elements to agree very well with design predictions. No significant changes in the dimensions of either the fuel assemblies or the individual fuel plates were indicated. The corrosion-product film on the surfaces of the fuel plates was somewhat thicker than expected, particularly on the pretreated fuel elements. Consequently, this pretreatment of the fuel elements is undesirable. Even with the thicker film, however, the elements appeared to perform quite satisfactorily; extensive visual and metallographic examination of fuel plates from these elements showed no indications of any type of structural damage that could be considered indicative of an actual or incipient failure of the fuel elements. Since all four elements were in such good condition, it was concluded that the current HFIR fuel elements will perform quite satisfactorily throughout their normal lifetime under present operating conditions. The useful lifetime is apparently limited only by nuclear reactivity and not by any irradiation damage. (auth)

11984 (ORNL–4738) DEVELOPMENT AND OPERATION OF A HIGH-INTENSITY, HIGH-RESOLUTION NEUTRON RADIOGRAPHY FACILITY. Foster, B. E.; Snyder, S. D.; DeCarlo, V. A.; McClung, R. W. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 30p. Dep. NTIS.

A neutron radiography facility was put into operation at the 30-MW Oak Ridge Research Reactor (ORR) 24 ft below the surface of the pool near the face of the reactor core. With this facility, 4- × 20-in. radiographs can be made of highly radioactive objects irradiated in the ORR pool facility, within the reactor core, or elsewhere. Specimens as long as 10 ft can be examined by sequential exposures. Indium foil is used as the primary detector for subsequent transfer to x-ray film. The high (collimated) thermal neutron flux available (1.7×10^8 neutrons cm^{-2} sec^{-1}) allows the use of very small apertures and large ratios (270 to 1000) of collimator length to aperture size so that high-quality radiographs can be obtained with relatively short exposure times (3–5 min). The image quality is adequate to resolve 0.020-in.-dia holes spaced only 0.001 in. apart in a cadmium strip and to display a 0.003-in. dia wire separated from the image plane by $2^9/_{16}$ in. A principal application of the facility is the periodic inspection of nuclear fuels irradiation test capsules to determine the condition of the fuel, fuel and cladding dimensional changes, and location of thermocouples. (auth)

11985 NEUTRON RADIOGRAPHY OF WELD JOINTS. Porter, Charles R. (to General Electric Co.). U. S. Patent 3,612,874. 12 Oct 1971. Filed 16 Jul 1968.

A nondestructive neutron radiographic technique capable of producing improved radiographs of weld joints is disclosed. Lack of contrast in neutron radiographs of two pieces which have been welded together makes resolving fine gaps in the weld difficult. In the disclosed system, one of the two pieces to be welded is doped with a small amount of a material having a high neutron absorption cross section. This provides the desired radiographic contrast and permits the inspection of an entire weld in one radiograph. (Official Gazette)

11986 FINITE ELEMENT METHOD FOR PLATE BENDING ANALYSIS BY DECOMPOSITION OF DIFFERENTIAL OPERATOR. Kikuchi, Fumio; Ando, Yoshio (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 10, 597-9(Oct 1971).

A simple finite element method for plate bending problems is introduced and is tested numerically. The results are generally good, and it is shown that the proposed method is applicable to practical problems. The principal shortcomings of the method are that the moment of the plate cannot be easily obtained and that the kinds of applicable boundary conditions are limited. However, because this method is very simple and the number of nodal valuables required for calculation is probably smaller than with any other current method for finite element analysis, it should be found useful in solving certain categories of problems. (auth)

11987 ACOUSTIC EMISSION TECHNIQUES IN MATERIALS RESEARCH. Liptai, R. G.; Harris, D. O.; Engle, R. B.; Tatro, C. A. (Univ. of California, Livermore). Int. J. Nondestruc. Test.; 3: No. 3, 215-75(Dec 1971).

A review of the application of emission analysis to evaluate materials properties and defect structure is presented. Topics discussed include fracture toughness and crack propagation, fatigue, plastic deformation, and creep processes in metals, composites, and rock materials. The status of emission techniques as applied to the evaluation of structural integrity is reported. A complete discussion of experimental techniques and data acquisition and processing systems is given. It is concluded that acoustic emission techniques have wide applicability to experimental studies in materials research and to evaluation analysis of structural integrity. Directions of future developments and applications are discussed. (auth)

11988 DEVICE FOR STUDYING THE CREEP STRENGTH OF CONSTRUCTIONAL MATERIALS UNDER IRRADIATION. Votinov, S. N.; Losev, N. P.; Prokhorov, V. I.; (and others). Strength Mater. (USSR) (Engl. Transl.); 3: No. 4, 483-6(Apr 1971).

Translated from Probl. Prochnosti; No. 4, 109-12(Apr 1971).

Equipment for determining creep strength of reactor materials in radiation fields is described. Tubular test specimens are loaded internally by gas pressure and cylindrical test specimens are mechanically loaded and exposed to in-pile radiation. The equipment provides means for testing over the pressure range of 0 to 350 kg/cm^2 and temperature range of 500 to 750°C. (J.R.D.)

11989 APPARATUS FOR DETECTING FAILURES OF NUCLEAR FUEL ELEMENTS. Tone, Hirohito (to Nihon Genshiryoku Kenkyusho). U. S. Patent 3,617,709. 2 Nov 1971. Filed 28 Mar 1969.

An apparatus is provided for detecting failures in nuclear fuel elements. Specific measurement of krypton and xenon as gaseous nuclear fission products is achieved by separating these elements from other coexisting radioactive elements and measuring the beta rays emitted from the krypton and xenon thus separated with a high counting efficiency. Separation is provided by passing the combined gases through separate columns filled with molecular sieve materials, or activated charcoal, in combination with a carrier Q-gas as used in a gas flow counter. (Official Gazette)

11990 NEUTRON RADIOGRAPHY. Berger, Harold (Argonne National Lab., Ill.). Annu. Rev. Nucl. Sci.; 21: 335-64(1971).

This review of neutron radiography concentrates on thermal-neutron methods, although radiography with neutrons of other energies is also considered. Neutron sources and image detection techniques are discussed. Applications of neutron radiography are indicated. (13 figures, 6 tables, 149 references) (R.W.R.)

Radioactive Material Handling

Refer also to abstracts 11488, 11535, 11562, 11827, 11932, 11984, 12029, 12174, and 12749.

11991 (ANL–7885) DESIGN DESCRIPTION OF ANL NITROGEN GLOVEBOX. Willis, F. L.; Dickerman, C. E.; August, C.; Dewey, G. G. (Argonne National Lab., Ill.). Nov 1971. Contract W-31-109-eng-38. 27p. Dep. NTIS.

A nitrogen-atmosphere glovebox has been installed in an ANL hot laboratory for handling sodium loops and plutonium-bearing fuel specimens following TREAT irradiation. This glovebox is equipped with a once-through nitrogen purging system which is exhausted through absolute filters. It is important that the outside surfaces of the loops do not become contaminated during handling and that contamination does not escape from the glovebox into the room. These conditions are satisfied by the transfer port, which is a distinguishing feature of this glovebox. By use of this device,

the Mark-II loops are attached to a closed penetration in the glovebox wall and sealed with O rings. The loop body remains outside the box while the closure flange is opened, and the test section containing failed fuel is withdrawn into the box. (auth)

11992 (BHO-68-7) INTEGRATED SAFEGUARDS EXPERIMENT. Fourth Quarterly Report, April-June 1971. Wadekamper, D. C.; Bishop, D. M.; Hagie, L. T. (eds.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Jul 1971. Contract AT(30-1)-68. 20p. (GEAP-12114-7). Dep. NTIS.

Data evaluation and limit of error calculations for passive neutron and replacement calorimetry measurements obtained during both Integrated Safeguards Experiments (ISE Campaigns 1 and 2) were completed. Incorporation of these measurements into material balances resulted in two additional plutonium MUF values for ISE Campaign 1. Similar calculations for ISE Campaign 2 resulted in trial material balances for total oxide, plutonium, and uranium. A second plutonium balance was obtained when passive neutron measurements were incorporated into the trial material balances. The present status of the Mechanized Accountability and Criticality System is summarized. (auth)

11993 (CONF-710402-(Vol.1), pp IV.39-42) NUCLEAR SAFEGUARDS AND MATERIALS MANAGEMENT. Menlove, Howard O. (Los Alamos Scientific Lab., N. Mex.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The implementation of an effective nuclear safeguards and materials management system requires direct physical measurement methods for fissionable materials. The nuclear materials are found in wide variety of configurations and mixtures and to be most effective, the measurement techniques should be nondestructive, rapid, accurate, and adapatable to the wide range of conditions encountered in the nuclear industry. Of the many nondestructive assay techniques under development, active neutron interrogation has proved to be one of the most useful for many practical applications. The application of a variety of neutron sources, both radioactive and accelerator sources, for the assay of fissionable material is described. (auth)

11994 (DOCKET-701193-1) CIMARRON PLUTONIUM PRODUCTION PLANT. Statement of Reasons Why Operation of the Plant Should Not Be Suspended Pending Completion of NEPA Environmental Review. (Kerr-McGee Corp., Oklahoma City, Okla.). 15 Oct 1971. 5p. Dep. NTIS.

11995 (DOCKET-701193-2) CIMARRON PLUTONIUM PRODUCTION PLANT. Statement of Reasons Why Operation of the Plant Should Not Be Suspended Pending Completion of NEPA Environmental Review, Revised. (Kerr-McGee Corp., Oklahoma City, Okla.). 13 Nov 1971. 12p. Dep. NTIS.

11996 (DOCKET-701193-3) CIMARRON PLUTONIUM PRODUCTION PLANT. Environmental Report. (Kerr-McGee Corp., Oklahoma City, Okla.). 9 Nov 1971. 18p. Dep. NTIS.

11997 (DOCKET-701193-4) CIMARRON PLUTONIUM PRODUCTION PLANT. Environmental Report, Revised November 1971. (Kerr-McGee Corp., Oklahoma City, Okla.). 24 Nov 1971. 50p. Dep. NTIS.

11998 (DOCKET-701193-5) CIMARRON PLUTONIUM PRODUCTION PLANT. Discussion and Findings Relating to Suspension of Operating License Pending NEPA Environmental Review. (Division of Materials Licensing (AEC), Washington, D. C.). 28 Dec 1971. 15p. Dep. NTIS.

11999 (IAEA-R-790-F) DEVELOPMENT OF SAFEGUARDS PROCEDURES FOR AN ALKEM TYPE PLANT FABRICATING PLUTONIUM FUEL ELEMENTS FOR FAST BREEDER REACTORS. Final Report, January 1-December 31, 1970. Gupta, D.; Drosselmeyer, E.; Hagen, A.; Kurz, P. (International Atomic Energy Agency, Vienna (Austria)). 137p. INIS.

The following main items were studied in order to develop an optimum safeguards system for the ALKEM fuel element fabrication facility: description of the plant-main facility data, including flows, handling and location of nuclear material; nuclear material accounting, measurement system, and instrumentation; simulation-mathematical model of a fabrication plant, input data for the model, main parameters in the model, simulated campaigns, results and conclusions; structure of a safeguards system for the plant-safeguards measures, safeguards procedures; and possibilities of improvements-instruments, shipper/receiver correlations, use of random sampling method, plant layout. The ALKEM plant which is the subject of the safeguards study is an automatized facility for the production of fuel pins both for thermal (0.5 to 4%) and FBR (10 to 16% Pu). It is expected to be in operation for 200 working days per year with daily throughput of about 10 kg of PuO_2. The complete production equipment is installed in one large hall which is divided by caissons in the following technological areas: conversion, powder preparation, pellet production, pin production, quality control, analysis and scrap recovery. For safeguards purposes it is proposed that the plant be divided into three MBA's (material balance areas), namely: storage, production, and area of analysis and recycle. Instrumentation which is in use in the plant includes: calorimetry in combination with neutron counting; mass-spectrometry-to establish to isotopic vector required for calorimetry; neutron counting (passive and active-for different types of waste streams; and instruments to control small amounts of plutonium carried by a person. Considering the probability of diversion detection it was found that a diversion of more than 0.9% of input can be detected with a probability of 95%. (INIS)

12000 (IAEA-R-796-F) DEVELOPMENT OF SAFEGUARDS PROCEDURES FOR A REPROCESSING PLANT WITH MECHANICAL HEAD-END AND MIXER-SETTLER CONTACTORS USING A PUREX FLOW SHEET. Final Report, December 1, 1969-November 30, 1970. (International Atomic Energy Agency, Vienna (Austria)). Feb 1971. 74p. INIS.

For the purpose of this study, a model plant was selected as follows: Type of the plant-a plant with mechanical head-end and mixer settler contactors using a Purex flow sheet; capacity of 1t(U)/day; fuels to be processed-fuels of light-water reactor with the initial uranium enrichment of up to 5%, containing 11.2 kg of Pu/T(U), which corresponds to the burnup of about 30,000 MWD/t; and final products are uranium trioxide powder and concentrated plutonium nitrate solutions. In order to apply safeguards to the plant, three safeguards measures could be used, namely, material accountacy, containment, and surveillance. For accountability and managerial purposes, operators of reprocessing plants usually identify three main Material Balance Areas (MBAs). These MBAs can, at the same time, be used effectively for safeguards purposes. They are: the feed storage consisting of the area between irradiated fuel reception and measurement in the input accountability vessel; process area consisting of the area between input accountability vessel and the product load-out; and the product store consisting of the area between product load-out and product shipment. Accountability procedures were studied in order to establish the sound accountability system of the plant. Analysis of accountability system in the plant was carried out to estimate the variance of MUF by utilizing the conventional statistical method and available data concerning the measurement errors. Campaign size and the effect of in-process inventory are taken into account in the MUF evaluation. (INIS)

12001 (LA-DC-13192) REAL PROBLEMS; REAL SOLUTIONS. Menzel, Joerg H. (Los Alamos Scientific Lab., N. Mex.). [nd]. 24p. (CONF-711034-1). Dep. NTIS.

From Symposium on implementing nuclear safeguards; Manhatten, Ks. (25 Oct 1971).

Limitations of methods used to implement nuclear safeguards in the U.S. are discussed. It is noted that the quantitative uncertainty of scrap inventories represents a large loophole in nuclear materials accountability. Development of nondestructive assay techniques and instrumentation for application to fissionable material throughout the fuel cycle is discussed. Slides are used to illustrate assay systems developed at LASL. (J.R.D.)

12002 (NP-19090) DETERMINATION OF FISSION PRODUCTS BY MEASUREMENT OF DELAYED NEUTRONS. Baumung, Kurt (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1970. 82p. (In German). (INR-4/71-32). Dep. NTIS (U. S. Sales Only).

The possibility of determining the amount of fissile material in 200-liter scrap barrels by counting delayed neutrons was investigated. The fissions were induced by 14-MeV neutrons and slowed down 14-MeV neutrons produced by a pulsed neutron generator. The delayed neutrons were detected by a high sensitivity configuration of $^{10}BF_3$ counters. The radial, azimuthal and axial spatial dependence of the sensitivity was measured in barrel mock-ups. These contained strongly moderating (hydrogeneous) material of various densities or weakly moderating scrap (iron), respectively. The radial and azimuthal dependence turned out to be equivalent. By performing two measurements, the second with the barrel turned by 180°, and taking the average, the strong radial (azimuthal) variation of the sensitivity is reduced from a factor of 6 to about 20%. Axial dependence is strong but insensitive to the contents of the barrel. By measuring the barrel in layers it can be reduced to less than 10%. The variation of the detection probability with density of moderating contents found by experiment could be confirmed by Monte Carlo calculations and explained by a simple

theoretical model. By means of the "add-a-gram" technique this dependence is reduced from a factor of 7 to 10%. The discrimination between ^{235}U and ^{238}U was also studied and problems arising with Pu-containing scrap are discussed. (auth)

12003 (PINSTECH-71-1) SOLAR EVAPORATION OF LIQUID RADIOACTIVE WASTES (A FEASIBILITY STUDY). Mubarak, M. A.; Aziz, Abdul (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Health Physics Div.). 1971. 28p. Dep. NTIS (U. S. Sales Only).

Measurements of meteorological parameters such as the air temperature, relative humidity, wind speed, rainfall, duration and intensity of sunshine etc. were carried out. The general effect of these parameters on the evaporation from a Class A pan is reported. Effects of measures such as the addition of dyes and painting of tank surfaces, increasing the evaporation surface by using porous fibers or bricks partly immersed in the liquid, and increasing the radiation-receiving surface of tanks in order to increase the evaporation from open pans is discussed. Using the results of observations and the experimental data the design basis of two types of evaporators for the volume reduction of medium-level wastes is presented with particular regard to the possiblity of dispersion of radioactivity to the environment. It is concluded that solar energy can be effectively and economically utilized for the volume reduction of medium-level radioactive wastes particularly at small establishments. (auth)

12004 NECESSITY FOR THE EFFECTIVE USE OF RADIOACTIVE WASTES. Kato, M. (Tokyo Univ.). Genshiryoku Kogyo; 17: No. 7, 6-9(Jul 1971). (In Japanese).

With the increasing number of nuclear power plants it becomes increasingly important to efficiently use radioactive wastes. Radioisotopes recovered from wastes are used at present only as radioisotope tracers and for fueling radioisotope-powered generators. The increasing quantity of radioactive wastes from fuel reprocessing must be used effectively and may contribute to a decrease in electric power costs. ^{90}Sr and ^{238}Pu are effective as thermal and radiation sources due to their high specific activity. Their manufacturing cost has been calculated by USAEC. Increased use means their cost will decrease. (Japan)

12005 PORTABLE DEVICE FOR RADIOISOTOPE PHOTOGRAPHY. Pellier Cuit, Louis French Patent 2,063,757. 14 Jun 1971. Filed 30 Oct 1969. (In French).

A portable device to be used in radioisotope photography is described. It consists of a container with walls, which do not transmit the radiations emanating from a radioisotope capsule contained inside. This capsule can be moved pneumatically into an external tube. One of the ends of the external tube is connected to the internal tube of the container, while the other end is provided with a part which stops the capsule. (France)

12006 STORAGE VESSEL. Schmeling, Per Erik (to Aktienbolaget Atomenergi). British Patent 1,256,035. 8 Dec 1971. Filed 10 Sep 1969.

Reference is made to small containers or ampules suitable for a radioactive gas or liquid. The container described comprises a metal or glass vessel, with non-leakage closure means comprising a thin metal disk or foil secured to its mouth by melting, soldering or welding, or application of high pressure together with a portion formed of elastomeric material, e.g., rubber, exterior to the metal part. The latter should be sufficiently thin as to be readily pierced by a hollow needle, such as the cannula of a hypodermic syringe. The first and second parts of the closure means may be secured together with an adhesive. (UK)

12007 MANIPULATOR CONTROL HANDLE. Germond, Jean-Claude; Guilbaud, Jean-Pierre; Vertut, Jean (to Commissariat a l'Energie Atomique). British Patent 1,250,838. 20 Oct 1971. Priority date 22 May 1968, France.

A handle for controlling the opening or closing movements of a manipulator grab is described. The handle is hollow and incorporates a motor driven cable, a control switch, and a return spring controlling a reversing pulley over which the motion-transmitting cable runs. The design provides for establishing a relation between the grab tightness and manipulating force. The grab can be automatically locked. (J.R.D.)

12008 APPARATUS FOR WASHING ARTICLES. Mosselmans, Georges; Nienhaus, Jurgen (to EURATOM). British Patent 1,251,172. 27 Oct 1971. Priority date 10 Apr 1969, Netherlands.

An apparatus is described for washing contaminated articles, either radioactive or non-radioactive, with a warm mixture of water and a solvent which has a specific gravity lower than water and is immiscible with water. The washing equipment is contained in a vessel having a cooled cover with controlled vents. The vessel is divided into two compartments one above the other; the upper one is used to hold the articles to be washed and the lower one to house steam pipes, condensate, and a controlled vent. (J.R.D.)

12009 METHOD FOR SEALING THE CUT EDGES OF RADIOACTIVE FOILS. Purt, Gustav A. (to Cerberus AG). British Patent 1,249,789. 13 Oct 1971. Priority date 28 Mar 1969, Switzerland.

An improved method is described for sealing or closing exposed edges of radioactive foils in cases in which the non-radioactive protective layers have been breached. The protective layers contain at least one noble metal which diffuses into the area to be sealed when it is heated to about 60% of its melting point. (J.R.D.)

12010 POWDER-MANUFACTURING APPARATUS. Teboul, Albert (to Commissariat a l'Energie Atomique). British Patent 1,249,758. 13 Oct 1971. Priority date 7 May 1969, France.

A rotatable drum for preparation of corrosive or radioactive powders is described. The drum incorporates a normally closed valve connected to a feed duct and discharge duct depending on drum position. The feed and discharge ducts are equipped with means for opening the valve. Operation of the rotating drum can be adjusted to the nature of the material to be treated and to the operation of other associated production line devices. (J.R.D.)

12011 ILLUMINATION AND CONTROL INSTALLATIONS FOR HIGHLY RADIOACTIVE ROOMS. Auracher, H. BBC-Nachr.; 53: No. 3-4, 101-6(1971). (In German).

Two hot cells in the WAK are equipped with remote-handled lamps. The individual components, such as switchboard, control desk, threaded plugs, installation channels are described and their radiation stability and materials are given. (INIS)

12012 IMPROVEMENTS IN OR RELATING TO THE TESTING OF RADIOACTIVE MATERIALS. (to Sen Electronique). British Patent 1,248,822. 6 Oct 1971. Priority date 16 Aug 1968, Switzerland.

A method is described for measuring the individual emissive properties of a plurality of radioactive specimens. The emission from each specimen is simultaneously detected by two or more detectors in order to select coincidences of detected events. Characteristically a plurality of specimens are examined simultaneously by a single detector, and the data received by the detectors are logically analyzed to ascertain the emissive properties of each individual specimen. (J.R.D.)

12013 HANDLING OF BIOLOGICAL RADIOACTIVE WASTES. Feher, L. (Fovarosi Koezegeszseguegyi es Jarvanyuegyi Allomas, Budapest). Izotoptechnika; 14: No. 6, 13-20(Jun 1971). (In Hungarian).

A method for the disposal of radioactive biological wastes based on the embedment of formaline-preserved carcasses in concrete, plaster, and bitumen is described. (auth)

12014 ARTICULATED MASTER-SLAVE MANIPULATOR. Germond, J. C.; Guilbaud, J. P.; Vertut, J. (to Commissariat a l'Energie Atomique). French Patent 2,061,941. 1 Jun 1971. Filed 3 Oct 1969. (In French).

A master-slave manipulator is described that consists of an assembly of articulated slave components that communicate, by means of a tube, through a wall with the master assembly, each assembly possesses at least two segments. The order of the segments, which corresponds to the different movements, is different in the two assemblies. The slave assembly consists of two segments assembled in a particular order relative to the tube crossing the wall. After crossing the wall the master assembly consists of an upper semi-second segment, which drives the second segment of the slave assembly and a first segment, which drives the first segment of the slave assembly and a lower semi-second segment. The two semi-second segments are in a fixed angular position relative to one another. (France)

12015 PADUCAH DEMONSTRATION CASK (27 Feb 1969) (Engineering Materials). (Paducah Gaseous Diffusion Plant, Ky.). (CAPE-2150).

9 drawings.

A shielded cask utilizing laminated U metal as the shielding material is described. The cask is used to ship spent fuel elements. Because of the high density of U metal, the shield weighs less than 75% of a Pb shield and less than 50% of a steel shield of comparable radiation attenuation. The cask is a right circular cylinder with an end closure and a large L/D ratio. The pressure-relief, vent, and drain valves are located within the stainless steel enclosure. A lifting yoke fits into two sockets which are welded to

the cask. (For details see TID-4100, Suppl. 67) (see also NSA 23: 17730, 23: 19923, and 23: 24414) (F.S.)

12016 EMPIRICAL FORMULA THAT PREDICTS THE CRITICAL PARAMETERS OF A URANIUM SOLUTION SLAB-CYCLINDER SYSTEM. Clark, Harold E.; Tuck, Grover (Dow Chemical Co., Golden, Colo.). Nucl. Technol.; 13: No. 3, 257-63(Mar 1972).

An empirical formula was developed for the criticality specialist who does not have a computer readily available which calculates the individual cylinder diameter for a critical uranyl nitrate solution slab-cylinder system. The formula is used to calculate the criticality condition for an accidental leak in an array of fissile-containing vessels, which forms a solution slab under the array. The critical system consisted of a square array of 1, 4, 9, or 16 vertical, equal-diameter cylinders resting on and interacting with a horizontal slab. Both the array and the slab were filled with approximately 495 grams uranium per liter uranyl nitrate solution with the uranium enriched to 93.2 weight-percent ^{235}U. The empirical formula, which predicts the critical unit cylinder diameter of the slab-array system, is $D_s = [D_a - 1.0 + (5.23 + 4.57\sqrt{N}/S/T - 12.8)][(239.0/C - 12.0) + 22.0]/22.4$ where D_a is the critical unit cylinder diameter of the array alone at 500 g U/liter. The independent variables are the number of cylinders, N; the edge-to-edge spacing between nearest neighbored cylinders in cm, S; the array solution height in cm, H; the solution concentration in g U/l, C; and the solution slab thickness in cm, T. The calculated unit cylinder diameter, D_s, in cm, is within ±11% of the experimentally measured diameter for 65 critical slab-array systems. This accuracy is sufficient for calculating the accident condition for nuclear safety purposes. Monte Carlo calculations were performed on some typical experimental configurations. The average k_{eff}'s range from 0.977 ± 0.017 to 0.996 ± 0.012. By increasing the slab thickness by the experimental error, k_{eff} was increased to 0.998 ± 0.012. (auth)

12017 IMPROVEMENTS TO CONTAINERS FOR RADIOACTIVE AND SIMILAR SUBSTANCES. (to Robatel SLPI). French Patent 2,064,568. 28 Jun 1971. Filed 26 Sep 1969. (In French).

A container for transporting radioactive materials is presented; it possesses on one of its outer faces a cylindrical handling device which is easily gripped. The device is fixed to the envelope by a flat plate which distributes the forces. A hole in this flat plate allows the device to fold up against the plate without damaging the envelope in the event of the fracture of the base resulting from an axial shock. (France)

12018 RETURNABLE TYPE B GAS SHIPPING PACKAGE (May 1971) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-2160).

3 drawings.

The returnable Type B Gas Shipping Package, which complies with all applicable regulations, is used as a protective shipping enclosure for 8 and 12 in. diameter UF_6 cylinders. The outer-shell design is similar to that of the standard 18 gage steel drum. There is a cylindrical inner housing of 16 gage steel with a bolted neoprene-gasketed cover. (For details see TID-4100 Suppl. 68) (see also 26: 297). (F.S.)

12019 DEVICE FOR BREAKING AMPULES CONTAINING HIGHLY RADIOACTIVE SOLUTIONS. Kocik, Jan; Vasek, Miloslav; Chadima, Petr (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 17: No. 12, 414-15(Dec 1971). (In Czech.).

A facility was constructed for opening ampules which contain highly radioactive solutions. The glass ampules became brittle due to the radiation and radiolysis caused the release of hydrogen with the result that opening the ampules was regularly attended by explosions and ignition of the hydrogen. Radioactive aerosols thus produced contaminated both personnel and the environment. A conveniently small facility was designed which could hermetically seal thereby permitting operation inside a glove box. Handling 5 to 10 curies of ^{90}Sr (^{90}Y) is now possible without contamination and excessive exposure of the operators. (tr-auth)

12020 SIMULTANEOUS DISPERSION AND DECAY OF RADIOACTIVE WASTES. Choi, S. K.; Fan, L. T.; Erickson, L. E. (Kansas State Univ., Manhattan). Health Phys.; 22: No. 2, 177-86(Feb 1972).

A rate process governing the transport and decay of a radioactive substance in a solidified waste and a surrounding fluid is simulated mathematically. The solidified radioactive waste is often buried underground or disposed of in the sea and is brought into contact with groundwater or sea water. A certain radioactive component distributed in the solidified waste dissolves in the water and then diffuses out of the slab to the surrounding fluid because of the concentration difference. The decay of the radioactive substance in both the slab and the surrounding fluid of the system is an irreversible first order rate process. The analytical expressions for the change of concentration of the radioactive substance are derived through the use of a Laplace transformation technique both as a function of time and position for the porous body and as a function of time for the surrounding fluid. The mathematical expressions are used in predicting concentrations in the system as well as in determining the effective diffusivity and the decay coefficient of the radioactive substance. (auth)

12021 FLUID MODELING OF CRITICAL HEAT FLUX IN AN 18-ELEMENT BUNDLE. McPherson, G. D.; Ahmad, S. Y. (Chalk River Nuclear Labs., Ont.). Nucl. Eng. Des.; 17: No. 3, 409-27(1971).

A series of critical heat flux (chf) tests on a 9-foot, 18-element bundle simulating a CANDU-BLW fuel string, done at Columbia University was duplicated in Freon-12 at Atomic Power Constructions Limited (U.K.). Using "scaling factors" proposed by workers at the U. K. Atomic Energy Establishment, Winfrith, and the Chalk River Nuclear Laboratories the Freon results were converted to water-equivalent results and correlated. The correlation agreed with the chf measurements in water with an rms error of 7.8%. A second modeling technique, the compensated distortion approach proposed by Ahmad, was also used. A correlation fitted to the Freon data predicted the chf measurements in water with an rms error of 6.2%. It is concluded that accurate modeling of chf in multi-rod bundles is demonstrated for the case where identical geometries are used and chf correlations obtained solely from Freon experiments satisfactorily predict chf for water. (auth)

12022 DISPENSING AND QUALITY CONTROL. pp 899-965 of Radioisotope Production and Quality Control. Vienna; International Atomic Energy Agency (1971).

See STI/DOC-10/128.

The process of dispensing radioisotope solutions, particularly for medical applications, includes the following operations: storage of stock solutions; subdivision (pipetting); bottling; sealing; sterilization; and packaging. The equipment and procedures required for each of these operations and for quality control at each step are discussed in detail. The equipment and methods used for performing radioassays of radioactive solutions are described. (L.C.L.)

Vacuum Engineering

12023 NEW METALLIC SEALS FOR HIGH AND ULTRAHIGH VACUUM: DESCRIPTION AND PERFORMANCES. Verheyden, L.; Klein, K. (CCR-EURATOM, Ispra, Italy). Vacuum; 21: No. 9, 401-11(Sep 1971).

A metallic four-lip seal that has a cross section which is symmetric around its central point 0 and inclined over an angle α with the plane of the flanges was previously described. It provides on each flange a leaktight contact on two lines and the contact surfaces have spherical shapes. Further development work on this seal is described relative to baking out under high-vacuum. A special feature of this seal, due to its geometry, is that it withstands thermal gradients on the flanges of 260°C. (Upper flange 260°C, lower flange 520°C.) The leaktightness remains always below the sensitivity of the leak detector, if an initial tightening force of 300 kg/cm circumference is applied. From results obtained on the four-lip seal, designs of three-lip static seals originated. A description of these is given with their special features and application possibilities, and a comparison is made between the four types of seals. (UK)

12024 ULTRAHIGH VACUUM ASPECTS OF THE INVESTIGATION OF SURFACE PHENOMENA. Rapparini, R. (Common Research Centre, Petten, Netherlands). Vacuum; 21: No. 9, 385-7(Sep 1971).

The investigation of surface structures and phenomena by such techniques as low-energy electron diffraction and high-energy electron diffraction has become possible in recent years due to the development of pumping and measuring devices able to produce and monitor vacua of the order of 10^{-12} torr. At these pressures, surfaces can be kept clean for as long as a few hours; in this way it is possible to investigate clean surface structures and surface phenomena such as adsorption-desorption with a minimum of trouble due to the presence of residual gases. The problem of degassing is discussed in detail. Particular attention is paid to the problem of the generation of clean surfaces by pulsed laser bombardment, sputtering, and annealing. The characterization of the degree of cleanliness of surfaces is treated and reference is made in some detail to those methods based on electromagnetic interactions of radiation with matter, e.g., Auger electron spectroscopy, electron spectroscopy for chemical analysis, and characteristic x-ray spectroscopy. (auth)

ENVIRONMENT AND EARTH SCIENCE

Geology and Hydrology

Refer also to abstracts 12077 and 12187.

12025 (BARC-573) BIBLIOGRAPHY ON HYDROLOGICAL CONSIDERATIONS IN (i) WATER RESOURCES FOR AGRICULTURE (ii) GROUND DISPOSAL OF RADIOACTIVE WASTES: DESALINATION AND EFFLUENT ENGINEERING DIVISION. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 373p. Dep. NTIS (U. S. Sales Only).

References (1465) are given to books, reports, theses, and journal items published up to January 1971. The main bibliographic source was Nuclear Science Abstracts but other scientific journals dealing with hydrology, flow through porous media, soil physics etc. were also consulted and abstracted. In addition to the materials identified in Nuclear Science Abstracts from 1960 to January 1971, earlier works from various textbooks and scientific reports have also been included. The references are presented subject-wise, which includes: textbooks, handbooks, guide books in hydrology; hydrology; use of tracers in hydrology; ground water flow; determination of ground water velocity; determination of permeability; determination of hydrological characteristics; hydrological mapping; determination of soil moisture and soil density; apparatuses, techniques used in hydrology; field studies on disposal of radioactive wastes; migration of radioisotopes into ground, transport of radioisotopes in lakes/rivers/ocean; adsorption of radioisotopes on soils; ground water monitoring and analysis; ground water resources; charge-recharge; pumping tests; theories of groundwater motion; dispersion in porous media; steady/unsteady, saturated/unsaturated, flow in homogeneous/heterogeneous media; solution of ground water flow equation; analog models for hydrologic studies and computer programs; predictive methods for groundwater flow; research work in hydrology through IAEA contracts; hydrology work in Arab countries; ground water management. (auth)

12026 (CONF-710402-(Vol.1), pp III.1-7) NUCLEAR TECHNIQUES FOR MINERAL EXPLORATION. Senftle, Frank E. (Geological Survey, Washington, D. C.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Several new nuclear techniques have been proposed for mineral exploration by several investigating teams at this conference. For uranium exploration a borehole method using either epithermal or delayed neutrons has been investigated, and the epithermal neutron method was found to be more efficient but had less penetration than the delayed neutron method. For undersea mineral exploration two teams of investigators have found the delayed gamma activation analysis a feasible technique for about 15 elements, although many practical problems still remain to be solved. For the operation of a solid-state detector in the ocean, down a borehole, or in space, a cryostat using a melting cryogen has been developed and tested. Preliminary results suggest that this sealed cryostat may be a potentially useful system for many nuclear applications where a liquid nitrogen cryostat cannot be used. (auth)

12027 (CONF-710402-(Vol.1), pp III.9-15) USE OF NEUTRONS FOR PETROLEUM AND GAS EXPLORATION. Caldwell, Richard L. (Mobil Research and Development Corp., Dallas, Tex.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

A summary is presented of the uses of neutron sources in the petroleum industry for nuclear well logging, beginning with the first neutron log run in 1941. The principal use of neutron logs over the past thirty years has been to measure the porosity of rocks which serve as reservoirs of oil and gas. Recent commercial developments are: the widespread use of the pulsed neutron log for oil–salt water differentiation in cased holes; and the use of helium-3 proportional counters in steady-state neutron logging for improved porosity determination in both open and cased holes. In research, attention is being given to improved neutron porosity logging using two neutron detectors at long spacings from a high intensity source, to activation logging with either a californium-252 or an accelerator source of 14-MeV neutrons, and to use of a high resolution solid-state detector for spectral gamma-ray analysis. The total revenue to service companies for oil well nuclear logging is about $40 million per year, of which the major portion is from neutron logging. (auth)

12028 (CONF-710402-(Vol.1), pp III.21-38) APPLICATIONS OF NEUTRON SOURCES TO GROUND-WATER HYDROLOGY. Meyer, G. Lewis (Teledyne Isotopes, Las Vegas, Nev.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Of nuclear techniques, the use of neutron sources and the interactions stemming from them hold particular promise for hydrologists as a tool for qualitatively and quantitatively defining the hydrological environment. Described for the hydrologist are the present and potential applications of neutron sources to his problems, some of the equipment available, and some of the advantages, and limitations to the method with particular emphasis on borehole logging. Neutron sources have been used or suggested for defining the following hydrologic parameters: lithology and correlation, identification of aquifers, moisture content, specific yield, fluid chemistry, direction and rate of ground-water movement, drilling and well construction, and geothermal investigations. The portions describing the potential applications and limitations of neutron methods in the hydrologic environment are intended to serve a second purpose; that of furnishing guidance to nuclear physicists and other specialists to areas where further development of theory, methods, and equipment are needed. (auth)

12029 (DOCKET-701292-2) FUELS FABRICATION PLANT. Environmental Report. (Nuclear Fuel Services, Inc., Rockville, Md.). 22 Dec 1971. 370p. Dep. NTIS.

An evaluation of the potential environmental impact of the planned Fuels Fabrication Plant to be built at the Western New York Nuclear Service Center at West Valley, New York, is presented. This revision incorporates clarification to and elaboration of certain information that was developed and presented in an earlier report dated June 23, 1971. A discussion of the following specific subjects is also included: environmental costs versus benefits of the proposed plant, analyses of the potential environmental effects of accidents, and potential environmental effects of the transportation requirements of the proposed plant. (R.C.K.)

12030 (RT/PROT-(71)21) PRELIMINARY STUDY OF SEVERAL SANDY AND GRAVELLY SPECIMENS OF C.R.N. IN TRISAIA AND OF EUREX IN SALUGGIA WITH THE IDEA OF PLACING A PHYSICO-CHEMICAL BARRIER IN THE AQUIFER. Cassano, G.; Diouhy, Z.; Lenzi, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 6 May 1971. 53p. (In Italian). Dep. NTIS (U. S. Sales Only).

The general hydrological features of two CNEN Nuclear fuel reprocessing Centers, the C. R. N. in Trisaia, and EUREX in Saluggia are described. The experiments made on some samples of soil taken from above-mentioned areas are described, and some experiments made, to determine the permeability coefficients, distribution and dispersion coefficients for ^{90}Sr, ^{137}Cs, and ^{106}Ru in dynamic conditions are also described. The influence of Ca^{++} ions concentration and the velocity of the elution water on the sorption ability of those soils were studied. Some preliminary experiments carried out in C. R. N. Trisaia to study the direction and velocity of water bearing stratum are described and the possibility of lowering the permeability and of increasing the ion exchange capacity of the aquifer by adding a clayed suspension to the aquifer is discussed. (auth)

12031 EFFECT OF THE DIAMETER OF DRY BOREHOLES ON DENSITY IN GAMMA-GAMMA WELL LOGGING. Popov, E. P. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 141-3(1969). (In Russian).

The proposed method of calculating the effect of diameter variation during gamma-gamma well logging by symmetrical 4π-geometry measurement makes it possible to determine the true density value in boreholes of variable diameter. A formula is given which relates the true and measured values of rock density as a function of borehole diameter and probe design. The parameters, for a given measuring apparatus, which enter into the formula are determined by measurements on two supporting strata in a borehole. (tr-auth)

12032 FALLOUT ^{137}Cs IN RESERVOIR SEDIMENT. Ritchie, J. C.; McHenry, J. R.; Gill, A. C.; Hawks, P. H. (USDA Sedimentation Lab., Oxford, Miss.). Health Phys.: 22: No. 1, 96-8(Jan 1972).

In 1969, five reservoirs and their contributing watersheds were sampled in Mississippi, New Mexico, and Arizona. Soil

samples were collected in the upland part of the watersheds in 5 cm increments to a depth of 10 cm. Samples of sediment deposited in the reservoirs were collected in 2.5, 5, or 10 cm increments from the sedimentation profile. Determinations of ^{137}Cs were subsequently made by γ spectrometry. Highest concentrations of fallout ^{137}Cs were usually below the sediment surface and some attempt was made to associate concentrations of fallout ^{137}Cs with various years of fallout, and to link sediment concentrations with various types of erosion. In all cases, the concentration of ^{137}Cs per unit area in the reservoir was greater than the average concentration of ^{137}Cs per unit area in the watershed. (UK)

12033 ROOF STABILITY IN THE VICINITY OF KARST DISTURBANCES OF THE LENINGRAD SCHIST DEPOSIT ACCORDING TO DENSITY DATA ON GAMMA–GAMMA WELL LOGGING. Popov, E. P. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 144-9(1969). (In Russian).

On the basis of specially-produced mine boreholes, a density character was obtained in the neighborhood of karst disturbances by means of gamma-gamma well logging. Regular changes in these properties and other factors offer the possibility of utilizing gamma-gamma well logging data for determining the optimum dimensions of protective ore pillars and a chance to improve productive capacity. (tr-auth)

12034 DETERMINATION OF ORE DENSITY AND HEAVY ELEMENT CONTENT ON THE BASIS OF TWO COMBINED MEASUREMENTS OF SCATTERED GAMMA RADIATION. Artsybashev, V. A.; Ivanyukovich, G. A. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 135-40(1969). (In Russian).

The density and heavy element content in an ore determines the practical solution of two simultaneous equations. A pair of combined γ-field measurements is accomplished by means of two probes: a ^{137}Cs source and scintillation detector with a 2 mm Pb filter for the probe length $R_1 = 30$ cm, and a ^{60}Co source and detector with a 3 mm Al filter for a probe length $R_2 = 20$ cm. The density of a Pb ore can be determined by these probes with an accuracy of ±2%, and the Pb content with an accuracy of ±15%. Methods are given for conducting measurements and interpreting the results. (tr-auth)

12035 INTERPRETATION OF DIAGRAMS OF A SHIELDED PROBE AND OF THE NEUTRON-GAMMA METHOD IN TERRIGENIC DEPOSITS OF THE SHAIM OIL FORMATION. Izvekov, B. I. Tr., Mosk. Inst. Neftekhim. Gazov. Prom.; No. 89, 79-83(1969). (In Russian).

The physical bases for joint interpretation of diagrams for specific electric conductivity and neutron-gamma methods include dependence of conductivity on the porosity coefficient in completely water-saturated rock; and the dependence of the neutron-gamma method on the water content of rock which is distinguished by its clay content together with a degree of porosity. Joint use of the conductivity method and the neutron-gamma method permits reliable discrimination by the pulse analyzer of the profile. Thus all profiles are scanned, and interpretation is not biased toward isolated layers. A composite diagram is shown of the neutron-gamma operation together with the shielded probe method, with interpretations by the pulse analyzer of bituminous clay as enclosed areas between the two tracings. Using the method described to determine the clay content of petroleum-bearing sandstones is attended with difficulty — that of determining the porosity of such beds by the conductivity method. However the method may still be considered convenient to quantitatively determine clay contents and for selection using analyzers. (K.S.W.)

12036 DETERMINATION OF STATISTICAL AND MATHEMATICAL ACCURACY OF RADIOACTIVE RADIATION INTENSITY BY RADIOACTIVE WELL LOGGING CURVES. Abdullaev, A. P.; Iskenderov, V. G. Izv. Vyssh. Ucheb. Zaved., Neft Gaz; 13: No. 10, 3-8(1970). (In Russian).

In radioactive well logging the radiation intensity of the stratum must be measured with a fixed accuracy. Two recommendations for determining mean square deviations of the statistical and mathematical expectation of the radiation intensity are given for well logging curves. The recommendations are quoted from an earlier paper by the authors and discussed in greater depth. (K.S.W.)

12037 ^{222}Rn CONTENT IN KAMCHATKA HYDROTHERMS. Chirkov, A. M. (Inst. of Volcanology, Petropavlovsk-Kamchatski, USSR). Dokl. Akad. Nauk SSSR; 199: No. 1, 202-3(1 Jul 1971). (In Russian).

The ^{222}Rn content is reported for a number of spontaneous gases occurring in Kamchatka hot springs. The temperature in different situations varied from 24 to 100°C. The maximum concentration of ^{222}Rn found ranged from $1{,}000 \times 10^{-10}$ Ci/l to 5×10^{-10} Ci/l. The higher values were generally associated with higher temperatures of certain hydrothermal systems and with foci of acid magmas. An apparent decrease in Rn content at one thermal source over the years 1967 to 1970 is discussed. (K.S.W.)

12038 GAMMA EMISSION IN SOIL AS A RESULT OF RADIOACTIVE FALLOUT. Pavlov, V. V.; Konstantinov, I. E.; Fedorov, G. A. At. Energ. (USSR); 31: No. 6, 639-40(Dec 1971). (In Russian).

The gamma radiation field of a soil sample was studied on the basis of a volumetric source with sharply decreasing concentration of radioactive material according to depth. Exponential approximations were compared with accurate but complex functions of radioisotope concentration with reference to depth of penetration in the soil. (K.S.W.)

12039 UNSUPPORTED $^{210}PoO_2$ IN SOIL: SOIL ADSORPTION AND CHARACTERIZATION OF SOIL SOLUTION SPECIES. Hansen, Wayne R.; Watters, Robert L. (Colorado State Univ., Fort Collins). Soil Sci.; 112: No. 3, 145-55(Sep 1971).

The adsorption of polonium-210 oxide by agricultural top soils was correlated with the silt content. The adsorption of polonium oxide on all soil horizons was correlated with both the pH and silt content of the soils. Equations were formulated from the data for prediction of the distribution coefficient of polonium in soils. Soil adsorption of $^{210}PoO_2$ expressed as a distribution coefficient, K_d, was confirmed by soil column elution experiments. Soils in columns with K_d's greater than 100 adsorbed greater than 98% of the $^{210}PoO_2$ in the first two cm with normal annual rainfall equivalent eluants. Soil in columns with a K_d less than 100 did not adsorb the total $^{210}PoO_2$ added, but allowed movement with water. Electrophoresis experiments indicated both positive and negative species of ^{210}Po in soil solution. Dialysis experiments with Visking dialysis membranes indicated an average of 34% dialyzable polonium species in soil solution after equilibration with the soil solid phases. (auth)

12040 OSMIUM ISOTOPES IN GEOLOGY. Riley, G. H. (Southwest Center for Advanced Studies, Dallas); Delong, S. E. J. Mass Spectrom. Ion Phys.; 4: No. 4, 297-304(Jul 1971).

The β-decay, $^{187}Re \rightarrow {}^{187}Os$, has a sufficiently long half-life to have applications in geology for both dating and natural isotopic tracer studies. Improvements in analytical techniques are needed to explore these applications and to establish the detailed geochemical relationships of rhenium and osmium with greater certainty. Despite the dearth of published data, the following trends are clear: rhenium is enriched into the crust relative to osmium; geochemical correlations between rhenium and molybdenum and between osmium and nickel seem plausible; there is sufficient rhenium in the mantle to modify the isotopic abundance of ^{187}Os in mantle derivatives, by a time dependent term; and a mantle Os/Re ratio comparable to that in chondritic meteorites satisfies common osmium isotopic abundances. (auth)

12041 DATING OF EARLY POSTGLACIAL LAND AND SEA-LEVEL CHANGES IN THE WESTERN FORTH VALLEY. Sissons, J. B.; Brooks, C. L. (Univ. of Edinburgh). Nature (London) Phys. Sci.; 234: No. 50, 124-7(13 Dec 1971).

Radiocarbon dates, pollen analysis and morphological and stratigraphic evidence relating principally to a small area in the western part of the Forth Valley (central Scotland) enable graphs of relative sea level changes and hence land uplift to be drawn for that area. (auth)

12042 THEORY OF NEUTRON METHODS. Krapivskii, E. I.; Brem, A. A. Vop. Razved. Geofiz.; No. 11, 86-8(1969). (In Russian).

The infinite-medium model is the most widely used mathematical model in the theory of neutron–gamma, gamma–neutron, and neutron–neutron methods, permitting valuable conclusions to be drawn for investigations and exploitation of many kinds of mineral resources. The diffusion-age approximation aided in the study of neutron distribution, and the ray approximation in studies of gamma-quanta distribution. The neutron–gamma method, the gamma–neutron (separate treatments for sub-thermal and thermal neutrons), and the neutron–neutron method are each briefly analyzed. (K.S.W.)

12043 APPLICATION OF THE Io/Th METHOD TO PHILLIPSITE AND THE GEOCHEMICAL CONSEQUENCES. Bernat, Michel (Office de la Recherche Scientifique et Technique Outre-Mer, Paris. Univ., Paris); Goldberg, Edward. Compt. Rend., Ser. D; 273: No. 4, 454-7(26 Jul 1971). (In French).

The Io/^{232}Th method for measuring the rate of sedimentation of marine sediments was applied to phillipsite. Phillipsite was isolated by sedimentation. The Th was separated by coprecipitation with LaF_3 followed by purification by extraction with organic solvents, and an electrodeposition. After eliminating the fluorides, the uranium was fixed by an anion resin, purified and electrodeposited. The decay of Th and U and the ^{226}Th/^{232}Th disequilibrium were studied using α spectrometry. (France)

12044 INTERPRETATION OF SPECTROMETRIC MEASUREMENTS MADE IN U DRILLINGS USING A Ge(Li) PROBE. Dumesnil, P. (CEN de Saclay, Gif-sur-Yvette, France); Andrieux, C.; Lenda, A. Bull. Instrum. Nucl.; No. 43, 15-19(Mar 1971). (In French).

A method is described enabling the variation with depth of the uranium content in a drilling bore to be calculated from γ ray spectra examined at regular depth intervals. The total absorption peaks at 185 and 242 keV are used. In the calculations, it is necessary to consider the linear attenuation coefficient of the rock at 185 keV. Thus the lithology of the matrix should be known as this permits the equivalent atomic number (Z-eq) of the matrix and the density of the rock to be determined. Other parameters involved in the calculation are the radius of the bore, characteristics of bore casing, and characteristics of the mud. Calibrations effected in concrete blocks containing known quantities of uranium (introduced in the form of ore) enable the correction constant for the effect of ^{226}Ra and the proportionality factor between the uranium contents and the measured activity of ^{235}U (185 keV) to be determined. (France)

12045 EVALUATION OF SNOW WATER EQUIVALENT BY AIRBORNE MEASUREMENT OF PASSIVE TERRESTRIAL GAMMA RADIATION. Peck, E. L. (National Oceanic and Atmospheric Administration, Silver Spring, Md.); Bissell, V. C.; Jones, E. B.; Burge, D. L. Water Resour. Res.; 7: No. 5, 1151-9(Oct 1971).

Recent research studies have investigated an airborne gamma radiation detection system for determining the water equivalent of snowpacks in nonmountainous areas. Snow attenuates natural gamma emissions from the soil and the magnitude of attenuation is related to the mass of the water blanket between the soil and the detector. Gamma spectral and total counting rates are collected and recorded by an airborne system using 14.4- by 4-inch sodium iodide (NaI (Tl)) crystals. These data are corrected for soil moisture, background radiation, and effects of air density. Extensive snow depth and density measurements were taken to determine "ground truth" water equivalent under the flight path. Results of the first year of research indicate that gamma spectral data may be expected to give areal measurement of snow water equivalent within at least 0.2 to 0.5 inch over favorable terrain. The use of total count data is even more promising but requires methodology still under development for eliminating background interference. (auth)

12046 METHOD AND WELL LOGGING APPARATUS HAVING ACOUSTIC AND NEUTRON PADS. Youmans, Arthur H. (to Dresser Industries, Inc.). U. S. Patent 3,608,373. 28 Sep 1971. Filed 4 Nov 1968.

A well logging instrument adapted for traversing an earth borehole has a neutron pad member on one side of the instrument which is normally spring-forced into contact with the borehole wall during such a traversal. The instrument has on its opposite side an acoustic pad which is also normally spring-forced into contact with the borehole wall during such a traversal. The acoustic pad has an acoustic transmitting transducer and a pair of acoustic receiving transducers for producing an acoustic time interval measurement. Each transducer is mounted on an acute angle from the longitudinal axis of the elongated instrument housing and is mounted in a fluid medium chosen to match the acute angle so that a steep rising wave front passes through the formation surrounding the borehole and produces a steep rising signal at the respective receivers, thereby permitting an accurate measurement of acoustic wave travel time from transmitter to first receiver and from first to second receiver. The neutron pad, having a capsuled neutron source and an epithermal neutron detector, responds to variations in formation porosity and to the thickness and constituency of mud and mud cake intervening between the pad and the formation. The acoustic pad serves to indicate the extent of the effect on the neutron-derived porosity measurement due to the mud and mud cake and permits a corrected porosity to be derived and recorded. (Official Gazette)

12047 SYSTEMS FOR NEUTRON DECAY TIME WELL LOGGING. Schwartz, Robert J. (to Schlumberger Tech. Corp.). U. S. Patent 3,609,366. 28 Sep 1971. Filed 1 Nov 1968.

In accordance with an illustrative embodiment of the present invention, a well-logging exploring device includes a pulsed neutron source which is repetitively energized to irradiate a formation with neutrons and means for generating a sync pulse representative of the time of termination of such irradiation. In response to this irradiation, a nearby scintillation counter generates signal pulses at a rate representative of the neutron population in the media surrounding the exploring device. The sync and signal pulses are then transmitted to the surface of the earth. At the surface of the earth, signal-processing circuits operate to accurately distinguish the sync and signal pulses and resolve any signal pulses which may have become merged due to the relatively low frequency response of the cable. These resolved signal pulses are then applied to computing circuits which operate to determine the rate of decay of the neutron population in the formation by determining the rate of change of the signal pulse repetition rate. In this connection, the signal pulses are weighted and then gated to a binary counter during a cycle of adjustable time intervals. By appropriately selecting the relationship of the time intervals to one another and the factors by which the signal pulses are weighted during each time interval, the accumulated count in the counter after each cycle of time intervals will be representative of the rate of decay of the neutron population and is used to determine the time intervals. The sync pulses synchronize the surface electronics with the repetitive irradiation of the formation with neutrons. (Official Gazette)

12048 VISUAL DISPLAY OF THE DECLINE OF THE THERMAL NEUTRON POPULATION IN A WELL BOREHOLE. Hopkinson, Eric C. (to Dresser Industries, Inc.). U. S. Patent 3,612,877. 12 Oct 1971. Filed 23 Jan 1968.

A well logging instrument having a pulsed neutron source and a radiation detector is adapted for travel through an earth borehole. The signal pulses from the detector are sent to the surface electronics, along with the neutron source synchronization pulses. In the surface electronics, the signal pulses are separated from the synchronization pulses. The synchronization pulses then drive a sawtooth generator, the duration of the ramp function being equal to the separation between the synchronization pulses. The signal pulses are coupled through a variable gain amplifier to a multichannel pulse height analyzer, the gain of the amplifier being a function of the slope of the ramp function. The multichannel pulse height analyzer drives an oscilloscope, thus providing a visual display of the declining curve representative of the signal pulses from the borehole instrument. (Official Gazette)

12049 MODELING OF PROBLEMS CONCERNING NEUTRON–NEUTRON WELL LOGGING ON NEUTRON-ABSORBING ELEMENTS. Krapivskii, E. I.; Sal'tsevich, V. B.; Suvorov, A. D. Vop. Razved. Geofiz.; No. 11, 95-8(1969). (In Russian).

The method of similitude has found wide application in the modeling of problems in nuclear physics, and in particular to neutron–neutron well logging (NNW). The equivalence of neutron parameters of model media and actual rock may be obtained by the addition of materials which have good neutron scattering or capture properties such as those of water, Be, C, B, and Li. B_4C was used as a neutron absorber in this study. It was found that NNW with thermal neutrons possessed the greatest sensitivity to changes in the content of neutron-absorbers. The content of neutron absorbers can be more quantitatively determined in a dry borehole than in one filled with water. The sensitivity of NNW was increased by using a Sb–Be neutron source rather than Po–Be. (K.S.W.)

12050 DEPTH OF NEUTRON–NEUTRON WELL LOGGING. Krapivskii, E. I.; Sal'tsevich, V. B. Vop. Razved. Geofiz., No. 11, 89-94(1969). (In Russian).

A simple method is proposed for estimating the depth of penetration of neutron–neutron well logging and required model measurements, suitable for cases in which the density distribution of the neutron flux is known in an infinite medium. By depth of penetration is meant the radius of that cylinder of the medium, on whose axis the neutron flux density from a point source of neutrons (also situated on this axis) comprises 90% of the neutron flux density in an infinite medium. It was concluded that the depth of penetration depends largely on the neutron properties of the rock and may vary within wide limits. The depth of penetration is proportional to the neutron moderation distance, but for hydrogen-free media is independent of the probe length. Approximate formulas are given for estimating these parameters. (K.S.W.)

12051 GEOTHERMAL POWER. Barnea, Joseph. Sci. Amer.; 226: No. 1, 70-7(Jan 1972).

New methods for extracting steam and hot water from natural underground reservoirs and for using this energy for heating and for producing electricity are discussed. (L.C.L.)

12052 EFFECT OF THE INTERMEDIATE ZONE ON THE SPECTRUM OF SCATTERED GAMMA RADIATION UNDER CONDITIONS OF GAMMA–GAMMA LOGGING. Ivanyukovich, G. A. Geofiz. App.; No. 42, 91-8(1970). (In Russian).

A study was made of the effect of an intermediate zone (water, air) on plane models of mediums of different density and composition (granite, cement, concrete) in gamma–gamma logging. The sensitivity of the method to the intermediate zone is minimum in the low-energy part of the spectrum, and when short sondes and hard gamma-radiation are used. To obtain minimum relative error in measuring density or effective atomic number of a medium, it is recommended that softer radiation sources be used if the intermediate zone is less than 20 mm, and harder radiation when it is more than 20 mm. The relative error is less for long sondes and detectors with maximum efficiency in the low-energy range of gamma-quanta. (Geophys. Abstr.)

12053 TWO DETECTOR PULSE NEUTRON LOGGING POROSITY TECHNIQUE. Schwartz, Robert J. (to Schlumberger Tech. Corp.). U. S. Patent 3,621,255. 16 Nov 1971. Filed 2 Oct 1969.

An illustrative embodiment of the invention discloses a technique for reducing the influence of borehole characteristics on earth formation porosity measurements. Measurements of this sort are accomplished with a borehole logging tool that comprises two neutron detectors spaced at different distances from a pulsed neutron generator. The thermal neutron decay time of the short-spaced detector identifies that portion of the time-dependent population that is most indicative of the formation porosity. Both detectors then register the portion of the neutron distribution so identified to produce two signals from which a ratio is computed that is related to the porosity of the formation. (Official Gazette)

12054 ANISOTROPY OF ^{137}Cs GAMMA-RAY ABSORPTION IN ROCKS. Vankova, Vera (Geophysical Inst., Prague). Stud. Geophys. Geod.; 15: No. 3-4, 364-71(1971).

The anisotropy of the ^{137}Cs gamma absorption coefficient was investigated in layered models and several rock samples. It was found that in contrast to other petrophysical parameters the gamma absorption coefficient is characterized by a relatively small coefficient of anisotropy (3 to 5%). Therefore, the possible effect of the anisotropy can be neglected in the measurements of u for rocks as it is usually below current observational errors. (auth)

12055 APPARATUS FOR GEOPHYSICAL WELL INVESTIGATIONS. Komarov, S. G. Geofiz. App.; No. 42, 78-87(1970). (In Russian).

The state of the technical provisions of geophysical logging apparatus is considered. Existing apparatus and equipment and those being developed are appraised, and the tasks and prospects of development of logging instrumentation are determined. (Geophys. Abstr.)

12056 ANALOG DEVICE FOR RADIOACTIVE LOGGING APPARATUS. Iskenderov, V. G.; Putkaradze, L. A. Geofiz. App.; No. 42, 109-14(1970). (In Russian).

The operation of a transformer which converts counting rate into analog voltage in radioactivity logging apparatus is analyzed on the basis of the theory of random functions. Analog device schemes are suggested which would eliminate the effect of high-frequency noise on the logs to a much greater extent than the integrators usually used and simplify the form of the curves, making them more obvious for manual processing and more convenient for conversion for computer interpretation. Results are presented of joint testing of the usual integrator and the proposed analog device. (Geophys. Abstr.)

12057 ATOMIC MINERAL DEPOSITS IN BIHAR MICA BELT. Bhola, K. L. (Atomic Minerals Div., New Delhi). Proc. Indian Nat. Sci. Acad., Part A; 37: No. 2, 145-68(Mar 1971).

The geology of the Bihar Mica Belt is discussed with special reference to controls for emplacement of pegmatites, their distribution, genesis and behavior both laterally and in depth. It also describes the occurrences of minerals required for atomic energy, like beryl, lithium minerals, columbite-tantalite, etc., in the pegmatites of this belt, which occupies the premier position in the country not only for mica, but also in respect of production and potentialities of these minerals. The possibilities of additional discoveries of deposits of beryllium, niobium and tantalum, etc., by geochemical prospecting and by exploration for large low-grade deposits of the same are also discussed. It is concluded that this rich and promising belt will continue to play an important role in India's industrial development by meeting the country's requirement of atomic minerals occurring in pegmatites. (auth)

12058 RADIOACTIVITY OF MESOZOIC ROCK IN APUSENI MOUNTAINS. Treiber, I.; Szabo, A.; Bedelean, I.; Cordis, V. Stud. Univ. Babes-Bolyai, Ser. Geol. Mineral.; 15: No. 1, 13-14(1970). (In Rumanian).

Radiological investigations of Mesozoic rock in the Padurea Craiului massif in the Apuseni Mountains are reported. A limited variation in radioactivity was noted, between 0.12 A-F/F for limestone rock, and 8.41 A-F/F for argillaceous rock. The activity of such rock was studied as a function of ZrO_2 and TiO_2 concentrations. Interdependencies of these kinds exist, with one exception: where an effect may be due to the presence of glauconite. (tr-auth)

12059 DUAL GAMMA-RAY PROBE FOR THE SELECTIVE GAMMA–GAMMA WELL LOGGING. Shul'gin, V. S.; Pshenichnyi, G. A. Vestn. Leningrad. Univ., No. 18, Geol., Geogr.; No. 3, 91-8(Sep 1971). (In Russian).

The dual gamma-ray probe described decreases the influence of the air and water gap, clay-case, and variable density when Z_{eff} changes in a wide range. This is impossible with any other probe including the inverted one. The sensitivity of this probe is almost the same as that of the inverted one. (auth)

12060 APPLICATION OF RADIOISOTOPE X-RAY FLUORESCENT LOGGING IN TIN–ORE ULACHAN–EGELJACH DEPOSIT OF JAKUTIA. Ivanyukovich, G. A.; Meier, V. A.; Filippov, M. M. Vestn. Leningrad. Univ., No. 18, Geol., Geogr.; No. 3, 85-90(Sep 1971). (In Russian).

The results of determining tin in tin-ore deposits by using the x-ray fluorescent apparatus with scintillation counters in boreholes are described. A ^{170}Tm source with Sm target was used. The method is based on measurement of ratio of characteristic to scattered radiation. According to logging data there is no icecase in the boreholes. The threshold pick-up of this method is 0.2 to 0.3%. (auth)

12061 STUDIES OF THE γ SPECTRA OF GEORGIAN MINERAL WATERS BY MEANS OF A Ge(Li) DETECTOR WITH HIGH RESOLUTION. Mosulishvili, L. M.; Kuchava, N. E. (Inst. of Physics, Tbilisi, USSR). Soobsch. Akad. Nauk Gruz SSR; 64: No. 3, 573-6(Dec 1971). (In Russian).

The γ spectra of Georgian mineral waters irradiated with neutrons were studied. (auth)

12062 PALAEOMAGNETIC AND RADIOMETRIC DATING RESULTS FROM JURASSIC INTRUSIONS IN SOUTH MOROCCO. Hailwood, E. A.; Mitchell, J. G. (Univ. of Newcastle, Eng.). Geophys. J. Roy. Astron. Soc.; 24: No. 4, 351-64(Dec 1971).

Samples collected from three Jurassic igneous formations in South Morocco carry a stable component of magnetic remanence, giving a mean palaeomagnetic pole-position at 61°S, 71°E, A_{95} = 14°. Two of the formations were situated in the stable Saharan Shield region, and one within the Central High Atlas fold-belt. There is no systematic difference between the pole-positions derived from these two regions of contrasting tectonic history, and furthermore, no significant difference between the mean Jurassic pole-position for Morocco and that for Southeast Africa. It is concluded that no significant post-Jurassic relative motion has occurred between NW and SE Africa. Two of the formations studied were previously thought to be Upper Palaeozoic, but radiometric age determinations give consistent values of between 181 and 187 My. These results indicate the occurrence of a widespread episode of Jurassic igneous activity, producing structures which frequently parallel the coastline, and are possibly related to the break-up and dispersal of the fragments of Pangaea during the Mesozoic. (auth) (UK)

12063 FILTRATION PROPERTIES OF ROCK DURING UNDERGROUND LEACHING OF URANIUM BY H_2SO_4. Beletskii, V. I.; Bakhurov, V. G.; Sadykov, R. Kh. At. Energ. (USSR); 31: No. 5, 518-20(Nov 1971). (In Russian).

Acid leaching experiments were conducted in columns which contained quartz sand with added small percentages of $CaCO_3$. Solutions of H_2SO_4 (5 to 100 g/l) were allowed to flow at predetermined rates through the columns (150 to 900 ml/hr), and the effect of gassing and settling of the bed on the flow rate through the column was determined. Gas evolution caused the greatest reduction in the filtration properties of the beds. Eventual siltation of the $CaSO_4$ formed resulted in a constant flow rate of liquid through the column after 2 hr or more. (K.S.W.)

12064 INSTRUMENT FOR SIMULTANEOUS RECORDING OF PULSED-NEUTRON AND GAMMA LOGS. Konoplev, Yu. V.; Kitsenko, Yu. A. Geofiz. App.; No. 42, 88-90(1970). (In Russian).

The instrument described makes it possible to subdivide a well section on the basis of clay content and to monitor the position of point measurements in pulsed neutron-neutron logging, by simultaneously recording pulsed neutron-neutron and gamma logs. (Geophys. Abstr.)

12065 SOME FEATURES OF SECONDARY GAMMA SPECTRA IN DIRECT VISIBILITY GEOMETRY AND THEIR USE IN THE X-RAY RADIOMETRIC METHOD. Mitov, V. N.; Yanshevskii, Yu. P.; Leman, E. P. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 122-7(1969). (In Russian).

The position of the line of once-scattered radiation depends on the angle between the collimators and the energy source. There are equilibrium points of the spectrum where the processes of absorption and generation are mutually compensated. These features of gamma spectra can be used in the x-ray radiometric method to enhance the sensitivity and reduce the effect of a number of interfering factors such as variations in mineralogical composition and texture of the ores. (Geophys. Abstr.)

Meteorology

Refer also to abstracts 11935, 12029, and 13245.

12066 (COO-2053-7) GASEOUS PLUME DIFFUSION ABOUT ISOLATED STRUCTURES OF SIMPLE GEOMETRY. Final Report, June 14, 1969-December 21, 1971. Meroney, Robert N. (Colorado State Univ., Fort Collins. Engineering Research Center). Dec 1971. 14p. Dep. NTIS.

The mechanisms of gaseous plume dispersal were examined. Results are presented of a systematic experimental study of the entrainment problem in the vicinity of rounded building geometries, the effect of thermal stratification on dispersion near building structures, and the effect of short-stack release height and exhaust velocities. The approach attempts to isolate the peculiarities of such configurations in an effort to make appropriate field predictions possible. The ultimate objective of this study on gaseous effluent behavior was to help develop a technology which will result in faster, safer and more economical dispersal of gaseous reactor wastes. (auth)

12067 (NYO-3425-5) PROGRESS REPORT. Reiter, Reinhold (Fraunhofer-Gesellschaft, Garmisch-Partenkirchen (West Germany). Physikalisch-Bioklimatische Forschungsstelle). 2 Dec 1971. Contract AT(11-1)-3425. 29p. Dep. NTIS.

Research on the penetration of stratospheric air into the troposphere continued with daily sampling of the atmosphere at Zugspitze, 2964 m a.s.l. in the Bavarian Alps, and with the analysis of samples for fallout heavy metals, ozone, and cosmic-ray generated ^{7}Be, ^{32}P, and ^{35}S content. The sampling and analysis methods are described in detail. The results are tabulated and plotted for the period from April 1 to Nov. 25, 1971. (L.C.L.)

12068 RADIOMETRY OF NATURAL RADIOACTIVE GASES OF RADON AND THORON AND THE INFLUENCE OF WEATHER PATTERNS ON THEIR CONCENTRATION IN THE ATMOSPHERE OVER SARAJEVO. Petrovic, Z.; Pasic, H. (Medicinski Fakultet, Sarajevo, Yugoslavia). Zb. Meteorol. Hidrol. Rad.; 3: 59-66(1969).

The concentration of natural radioactive gases of radon and thoron in the atmosphere over Sarajevo was determined by means of the radiometric method from April to October, 1960. The maximum radon concentrations in the air were very high, even 2.1×10^{-12} Ci/l, while the mean values coincided with the values given in the literature 3.3×10^{-13} Ci/l. Great variations of the levels of the mentioned natural radioactive gases are related to different weather-types. The precipitation types cause to a great extent a diminution of radon and thoron concentration in the air, while the maximum values are found in calm and cloudless weather without or with a weakly developed advection. (Bull. Sci., Sec. A)

12069 APPLICABILITY TO GREENFIELD'S MODEL OF GROSS β RADIOACTIVITY DATA IN FALLOUT AND AIR COLLECTED IN ITALY. Faloci, C.; Lucci, F.; Susanna, A. (CNEN, Rome). Atmos. Environ.; 6: No. 1, 69-72(Jan 1972).

Relationships between radioactivity values in air and fallout and precipitation in millimeters have previously been pointed out and compared with experimental data, but local situations and short periods only have been considered. In this study an attempt was made to ascertain whether the proposed models are still valid over large territories and long periods even when environmental radioactivity conditions differ considerably. The data analyzed came from twenty stations during a 7 yr period. An empirical function relating the average concentration of gross β radioactivity in air in a given period, the gross β radioactivity in the fallout sample collected in the same period and the total precipitation in the given period is compared with experimental data and found to be satisfactory. (UK)

12070 DETERMINATION OF THE NECESSARY DENSITY OF RADIOACTIVITY MEASUREMENT GRIDS USING STATISTICAL STRUCTURAL CHARACTERISTICS OF ARTIFICIAL BETA-ACTIVITY IN THE NEAR-SURFACE AIR. Zier, M. (Meteorologisches Observarotium, Wahnsdorf, Ger.). Kernenergie; 14: No. 6, 198-205(Jun 1971). (In German).

The horizontal extent of radioactive air masses is characterized by the macroscales L which can be estimated from empirical correlation functions. Such correlation functions were calculated from the daily means of artificial beta-activities of near-surface air determined by 21 Middle-European stations (9 in the GDR, 8 in Poland, 3 in Hungary, 1 in Czechoslovakia) for each month in 1963 and 1964. The macroscales fluctuated between 100 and 670 km. In average, the values were 292 km for meridional arrangements of the stations, 350 km for zonal arrangements, 373 km for summer half-year, 269 km for winter half-year. In accordance with this, a distance of 300 km for the stations of a radioactivity measurement grid is recommended. (auth)

12071 METHOD FOR MEASURING THE RADIOACTIVE DISEQUILIBRIUM BETWEEN RADON AND ITS SHORT-LIVED DAUGHTERS IN THE ATMOSPHERE. Bouville, A.; Leroy, B.; Guedalia, D.; Delos, Y.; Fontan, J. (Univ. Paul Sabatier, Toulouse). J. Aerosol Sci.; 2: No. 4, 381-7(Dec 1971). (In French).

A method for measuring radioactive equilibrium between radon and its daughters in the atmosphere is presented. Radon was measured after adsorption on active charcoal and the daughters (RaB and RaC) by γ-spectrometry during collection on a filter. The computation of the error made it possible to determine the best measurement procedure. The first results obtained show that the method presents a good sensitivity in the lower layers of the atmosphere. (auth)

12072 INCREASED ^{222}Rn CONCENTRATIONS IN THE ATMOSPHERE OF WATER TREATMENT PLANTS. Truelle, M. A. (Krajska Hygienicka Stanice Jihoceskeho Kraje, Ceske Budejovice, Czech.). Cesk. Hyg.; 16: No. 2-3, 98-102(Apr 1971). (In Czech).

A survey carried out in 8 water treatment plants showed that treatment of water containing increased concentrations of dissolved radon (up to 5600 pCi/l of ^{222}Rn) resulted in the contamination of the indoor atmosphere by ^{222}Rn. It was estimated that in certain instances the maximum permissible concentration of radon (3×10^{-11} Ci/l) was exceeded as much as 8 times. The level of equilibrium between radon and its decay products ranged from 52 to 78%. An increased radon concentration in the air was characteristic of installations with an intensive water-air contact. In one of the water treatment plants, the total amount of ^{222}Rn released from water over 24 hours was 4.2 mCi. Measures are proposed of reducing radon concentrations in the atmosphere of water treatment plants. (auth) (INIS)

12073 STRATIFIED REGIONS OF HIGH RADIOACTIVITY IN THE ATMOSPHERE OVER HYDERABAD, INDIA, IN APRIL, 1968. Manchanda, R. K.; Agrawal, P. C.; Biswas, S.; (and others) (Tata Inst. of Fundamental Research, Bombay). Tellus; 23: No. 4-5, 455-8(1971).

In a balloon flight from Hyderabad, India on April 28, 1968 with an x-ray telescope recording x-rays in the energy band from 16 to 125 keV, two stratified layers of high radioactivity in the atmosphere were observed at an altitude of from 16 to 20 km. The excess radiation was concentrated in the layers located at 16.4 to 17.2 km and 18.6 to 20.1 km separated by a region of normal counting rate. The two distinct layers of excess radiation were recorded in all the six different energy channels and the energy spectrum of the excess radiation was measured. A subsequent balloon flight from the same location with the same instrument on December 22, 1968 did not show any excess radioactivity in the atmosphere. It was concluded that the excess atmospheric radioactivity on April 28, 1968 originated from the global fallout from the nuclear detonation, presumably from the air burst by China on June 17, 1967. The interesting aspect of the present observations is the occurrence of stratified layers of activity in the tropopause region near equator several months after the explosion. (auth)

12074 APPLICATION OF THE IONOGRAPHIC METHOD TO THE DETECTION OF RADIOACTIVE ALPHA-EMITTING AEROSOLS. Wajsfelner, R. (CEN, Fontenay-aux-Roses, France); Bricard, J.; Madelaine, G. J. J. Aerosol Sci.; 2: No. 4, 375-9 (Dec 1971). (In French).

A film of cellulose nitrate was used to make a record of α-

particles. The film was exposed in a holder with a filter of aluminized mylar above and an absorbing metal block underneath. After the exposure it was developed in a solution of sodium carbonate; the α-particles left small perforations which were counted under a microscope. (auth)

12075 DISTRIBUTION OF NATURAL RADIOACTIVITY ON THE ENVIRONMENTAL SUBMICRONIC AEROSOLS. Havlovic, Vratislav; Snihs, Jan Olof (National Inst. of Radiation Protection, Stockholm). Tellus; 23: No. 4-5, 441-54(1971).

An electrical ion mobility analyzer has been built for the study of the environmental aerosol particle size spectrum and of the distribution of natural activity on this spectrum in the size range 10^{-5} cm > r > 10^{-6} cm. The mobility analyzer was carefully tested by a new method to prove the laminarity of flow and the air velocity distribution inside the apparatus. The quantity of charged aerosol particles classified into discrete mobility (or size) groups was estimated by the α radioactivity of collected particles tagged before entering the analyzer by ThB ions. The electrical mobility analyzer was then completed by a sonic jet diffusion charger for unipolar aerosol charging by diffusion and the electrical parameters of this device were tested to ensure reliable operation. The activity size spectra A(r) were transformed to relative particle size distribution curves N(r). The measurements were carried out in Stockholm, Sweden, under varying physical conditions. All experiments gave very similar results. The activity curves A(r) of positive and negative particles as a function of radius show a similar profile with a maximum in the region of radius r = 3–6 × 10^{-6} cm corresponding to Junge's model of aerosol particle distribution. The calculated relative particle size distribution curves N(r) are not always characterized by a peak as expected from Junge's model but are increasing below radii r < 10^{-6} cm, so that no peak is evident. (auth)

Mineralogy and Exploration

Refer also to abstract 12187.

12076 ACCUMULATION OF RADIOACTIVITY IN A CYLINDRICAL MINE WORKING. Putikov, O. F. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 113-21(1969). (In Russian).

An expression is given for the concentration of emanation showing that the accumulation rate is strongly dependent on the original conditions (time of deemanation of active ores). The formula of A. G. Grammakov was obtained as a particular case for zero time of deemanation and small values for time of accumulation. (tr-auth)

12077 GEOCHEMISTRY OF URANIUM IN CHANNEL SEDIMENTS OF THE STREAM NETWORK IN A MOUNTAINOUS TAIGA AREA. Kapkov, Yu. N. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 73-80(1969). (In Russian).

A study of the dispersion processes of uranium in granitoid development showed that the basic mass of transportable material occurs in the form of thin suspensions, true and colloidal solutions, and represents a significant fraction in rock-forming minerals, perhaps as much as 75 to 98%. Uranium is extracted by natural waters relatively easily. It does not play an important role in accessory minerals in the total balance of river-bed deposition. The mobility and the sorption property of uranium in organic material depend on the reaction medium, which in the mountainous Siberian forest region, leads to leaching of the uranium from the upper strata. All this causes a high geochemical background of uranium and the formation of "concentration" flows, and difficulties in separating out the "ore" flows. (tr-auth)

12078 COMPOSITION OF SOLUTIONS RESPONSIBLE FOR THE FORMATION OF U–Mo DEPOSITS. Barsukov, V. L.; Sushchevskaya, T. M.; Malyshev, B. I. At. Energ. (USSR); 31: No. 1, 28-34(Jul 1971). (In Russian).

The composition of hydrothermal solutions, which formed typical U–Mo ore deposits, was evaluated on the basis of gas-liquid inclusions in pitchblende and uraninite-bearing minerals. Aqueous extracts were analyzed for Na, K, Ca, Mg, Cl, SO_4, and HCO_3, and the thermodynamic instability constants of a number of Ca salts at 25 and 150°C were calculated as the basis for further discussion of the mechanics of ore formation. (K.S.W.)

12079 URANIUM INDUSTRY OF CAPITALISTIC COUNTRIES IN 1970. Andreev, V. D. At. Energ. (USSR); 31: No. 6, 610-18(Dec 1971). (In Russian).

Main trends in the development of the uranium industry in industrial well-developed and developing countries in 1970 were examined. Consideration was given to the considerable growth of the uranium reserves and resources in spite of some reduction in prospecting and explorating activity compared with the exceptionally high level of 1969; the expansion of mining and milling; and the intensive construction of new mines and mills. Costs and prices of the uranium concentrates in main producing countries are also discussed. (66 references). (auth)

12080 METHOD OF PROSPECTING FOR MINERAL DEPOSITS HAVING RADIOACTIVE GASEOUS DECAY PRODUCTS. Milly, George H. (to Geomet Mining and Exploration Co.). U. S. Patent 3,609,363. 28 Sep 1971. Filed 4 Mar 1969.

A method is described for prospecting, particularly prospecting for uranium, thorium and the like radioactive ore deposits having a gaseous decay product which diffuses through the earth's structure and becomes windborne. (Official Gazette)

12081 URANIUM IN SOLUTIONS OF OOZE DEPOSITS IN THE SOUTHEASTERN ATLANTIC. Baturin, G. N. (Inst. of Oceanography, Moscow). Dokl. Akad. Nauk. SSSR; 198: No. 5, 1186-8 (11 Jun 1971). (In Russian).

Determinations of uranium were made in ooze solutions of deposits after separation from the core samples under pressure. A range of 1.3 to 650 μg U/l was recorded for the samples under test; in the majority of cases the U content was significantly greater than in the ocean waters (3.2 g U/l). A correlation between pH and U content of samples is shown. (K.S.W.)

12082 SPECIAL FEATURES OF THE FORMATION OF HIGH URANIUM CONCENTRATIONS IN OXIDIZING MEDIUM. Borkov, F. P.; Egorov, N. I.; Zaytsev, E. V. (Moscow Geological Prospecting Inst.). Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; No. 5, 51-7(May 1971). (In Russian).

Special features of the localization and formation of high uranium concentrations in an oxidizing medium are investigated. The presence of a weathering crust is the characteristic feature of the geological zone structure. The uranium concentrations are at nonequilibrium. The coefficient of radioactive equilibrium fluctuates between 1 and 78%. The shift of radioactive equilibrium toward uranium and a nearly total absence of radium in samples indicate the recent age of mineralization and the continuation of deposition and redeposition processes. It is concluded that the ore was formed in the process of weathering crust formation because of the uranium redistribution liberated from the ore as a result of oxidation, on the one hand, and introduction of uranium from ground waters rich in ferro-hydroxides, jarosite, and phosphate ions, on the other hand. (JPRS)

12083 JADUGUDA: CERTAIN OBSERVATIONS REGARDING URANIUM AND BASE METALS MINERALIZATION. Venkataraman, K.; Shastry, S.; Srinivasan, M. N. (Uranium Corp. of India Ltd., Jaduguda). Proc. Indian Nat. Sci. Acad., Part A; 37: No. 2, 131-44(Mar 1971).

Radioactive prospecting and mining for uranium have been in progress in Jaduguda mines. The zone of economic uranium mineralization is about 1,000 m long and has been prospected up to a depth of 425 m. Details regarding the structural controls of uranium and base metals mineralization in the Jaduguda deposit are outlined. The spatial relationship between uranium and the base metals is also discussed in the light of geophysical and geochemical (soil) surveys. The probable sequence of tectonic and metasomatic activity in Jaduguda is also discussed. (auth)

12084 ORIGIN OF ^{21}Ne IN RADIOACTIVE MINERALS. Shukolyukov, Yu. A.; Sharif-Zade, V. B.; Ashkinadze, G. Sh.; Gerling, E. K. At. Energ. (USSR); 31: No. 5, 530-1(Nov 1971). (In Russian).

Nine possible nuclear reactions may be listed which yield ^{21}Ne or ^{22}Ne, but lack of knowledge regarding losses of the isotopes during geologic time preclude any quantitative conclusions. Data are presented which eliminate uncertainty as to losses. Using the ^{21}Ne/^{20}Ne and ^{22}Ne/^{20}Ne ratios in the formula suggested, it is concluded that the source of the isotope ^{21}Ne is the reaction ^{18}O(α,n)^{21}Ne. (K.S.W.)

12085 NUCLEAR ENERGY IN THE 1970s. Eklund, S. At. Energ. (USSR); 31: No. 5, 487-95(Nov 1971). (In Russian).

The world U_3O_8 requirements are predicted to rise from 10,000 short tons (one short ton = 907 kg) in 1970 to 78,000 in 1980, by which time the total U_3O_8 consumed will have increased to 447,000 short tons. The USA, Canada, S. Africa, and France have 85 to 90% of the proven reserves of cheap U, and about ⅓ of all U is a by-product of other extractions, such as Au in S. Africa, and Cu and phosphate in the USA. Uranium concentrates and U enrichment are discussed. Nuclear power will increase from 24,000 to 330,000 MW over the 1970 to 1980 period. The harmful effects on the environment are surveyed, in particular the fission products ^{137}I, ^{90}Sr, ^{99}Tc, ^{103}Ru, ^{144}Ce, ^{131}I, and ^{85}Kr. Future uses of atomic explo-

sions for construction purposes, etc., throughout the world are reviewed. (K.S.W.)

12086 ROLE OF STRUCTURAL AND MORPHOLOGICAL FACTORS IN FORMING HYPERGENESIS ZONES OF FRACTURE TYPE IN URANIUM–MOLYBDENUM DEPOSITS. Skvortsova, K. V.; Modnikov, I. S. At. Energ. (USSR); 31: No. 5, 453-8 (Nov 1971). (In Russian).

The importance of the structure and shape of ore bodies for forming fracture-type hypergenesis zones for the group of uranium-molybdenum deposits connected with volcanic apparatus of Devonian age is described. The study determined that the art of segregation and the vertical distribution of minerals in the fracture zones of oxidized ores are dependent on the conditions of circulation of superficial oxidizing waters along the fractures in ore bodies. For some types of uranium–molybdenum ores having the same composition of hypogenic bodies, the formation of hypergenic ores with different composition is possible. As a result of the investigation general regularities of zonal distribution of uranium–molybdenum minerals in the zone of hypergenesis are outlined. This is important for the estimation of the depth of the erosional shear of ore deposits. (auth)

12087 URANIUM-BEARING MINERAL BOLIVARITE: NEW DATA AND A SECOND OCCURRENCE. Van Wambeke, L. (EURATOM, Ispra, Italy). Mineral. Mag.; 38: No. 296, 418-23 (Dec 1971).

A second occurrence of the mineral bolivarite was found in the Kobokobo pegmatite, Kivu, Republic of Congo (Kinshasa). This amorphous mineral was previously considered to be evansite. Its physical properties are: weak birefringence; biaxial to uniaxial positive; n = 1.50 to 1.51; specific gravity 1.97 to 2.05; hardness 3 to 3.5. Three chemical analyses were performed on the Congolese material. The general formula of the mineral is $Al_2(PO_4)(OH)_3 \cdot 4-5\ H_2O$. Both known bolivarites from Spain and Congo contain abnormal amounts of U. The bright green uv fluorescence is due to the presence of U. The DTA curve of the Congolese bolivarite is given. Its genesis is discussed. This uranium-bearing mineral may be an indicator of uranium mineralization in Spain. (auth)

Oceanography

Refer also to abstract 12282.

12088 INVESTIGATION OF THE TRANSPORT OF ATOMIC INDUSTRIES EFFLUENTS DISCHARGED BY GREAT BRITAIN INTO THE IRISH SEA. Markelov, V. N.; Nelepo, B. A. (In Russian).

Results of experimental studies of ^{90}Sr concentration in the northeastern part of the Atlantic Ocean adjacent to the sites of the discharge of radioactive effluent from atomic industries of Great Britain are presented. A theoretical method is developed for calculations of spatial distribution of radioactive admixtures discharged into the sea from stationary sources depending on various hydrophysical conditions. Comparisons and estimates of agreement between theoretical and experimental data on the transport and spatial distribution of radioactive admixture in the sea are made. (auth)

Seismology

12089 SEISMICITY OF NORTHERN AND CENTRAL CALIFORNIA, 1965–1969. Bolt, Bruce A.; Miller, Roy D. (Univ. of California, Berkeley). Bull. Seismol. Soc. Amer.; 61: No. 6, 1831-47(Dec 1971).

Detailed seismicity ($M \geq 2.5$) of northern and central California for 1965 to 1969 was analyzed. The largest earthquakes were nine with magnitudes $5.0 < M < 6.0$. Since the interval, 1962 to 1965, seismic activity has increased north of Corralitos on the San Andreas fault. Seven shocks were located in the western reaches of Monterey Bay. The histogram of focal depths (d) for the coast ranges shows all $d < 16$ km and 50 per cent with $0 < d < 5$ km. North of Cape Mendocino, the new Fickle Hill telemetry station shows that within $30 < \Delta < 85$ km of FHC, only 15 per cent of recorded earthquakes ($M \geq 2.5$) has $M > 3.0$, and an average of 14 earthquakes ($M \geq 2.5$) occurs each month. Some foci are as deep as 25 km in this region. For northern California, the linear recurrence law gives $b = 0.78 \pm 0.04$, slightly less than southern California. For the coast ranges, $b = 1.00 \pm 0.04$. The water loading of Oroville reservoir in 1967 to 1968 has not been associated with increased seismicity in the area. On the present homogeneous data, a statistical t-test shows that the short-term occurrence rate of northern California earthquakes was not altered by large underground nuclear tests in Nevada. (auth)

12090 SEISMIC DISCRIMINANT BASED ON FOCAL MECHANISM. Syed, Atiq A.; Kisslinger, Carl; Nuttli, Otto W. (Saint Louis Univ.). Bull. Seismol. Soc. Amer.; 61: No. 6, 1827-30 (Dec 1971).

Utilizing the observation that a predominant focal mechanism exists for a given hypocentral region, a seismic discriminant based on body-wave magnitude has been developed. This discriminant enables one to identify earthquakes that do not fit mechanisms expected from plate tectonics. It also sorts out explosions as anomalies, even for those regions in which the focal mechanism results in compressional first motions at most or all available seismograph stations. (auth)

12091 SEISMIC CHARACTERISTICS OF UNDERGROUND NUCLEAR DETONATIONS. PART II. ELASTIC ENERGY AND MAGNITUDE DETERMINATIONS. Murphy, John R.; Mueller, Richard A. (Environmental Research Corp., Las Vegas, Nev.). Contract AT(29-2)-1163. Bull. Seismol. Soc. Amer.; 61: No. 6, 1693-1704(Dec 1971).

An expression is derived for the elastic energy produced by a contained, underground nuclear detonation using an analytic approximation for the pressure profile acting at the elastic radius. The resulting static strain energy and radiated energy equations are evaluated as a function of yield and depth of burial for detonations in tuff and rhyolite. It is shown that, for a given medium, the elastic-energy efficiency depends only on the depth of burial (h) of the device and is proportional to $h^{0.72}$. Moreover, for the particular scaling relations used, the strain energy shows the same depth dependence as the radiated energy. Seismic-spectrum scaling theory is applied to an analysis of nuclear seismic-source functions, giving results which are in good agreement with the observed differences in the teleseismic magnitude determinations. A magnitude-energy equation is derived for underground nuclear detonations and is noted to be in poor agreement with the Gutenberg–Richter equation. This discrepancy is interpreted to be an indication that the radiated energy from small earthquakes may typically have been underestimated. (auth)

12092 SEISMIC CHARACTERISTICS OF UNDERGROUND NUCLEAR DETONATIONS. PART I. SEISMIC SPECTRUM SCALING. Mueller, Richard A.; Murphy, John R. (Environmental Research Corp., Las Vegas, Nev.). Contract AT(29-2)-1163. Bull. Seismol. Soc. Amer.; 61: No. 6, 1675-92(Dec 1971).

A seismic-spectrum scaling model based on an analytic approximation to the nuclear seismic-source function is described and evaluated in terms of the behavior of a large body of measured spectral data. The results of the scaling analysis indicate that the yield, depth of burial and emplacement medium of the nuclear device play significant roles in defining the seismic-spectrum scaling of underground nuclear detonations. Results are presented which indicate that cube-root-yield scaling of the nuclear seismic-source function is not appropriate. For events buried sufficiently deep for containment, the scaling theory predicts frequency-dependent yield exponents ranging from 0.90 at low frequencies to 0.45 at high frequencies. These yield-scaling exponents are in good agreement with empirical relations statistically derived from measured data. (auth)

12093 GENERATION OF SEISMIC WAVES BY EXPLOSIONS IN PRESTRESSED MEDIA. Toksoez, M. Nafi; Thomson, Ker C.; Ahrens, Thomas J. (Massachusetts Inst. of Tech., Cambridge, Air Force Cambridge Research Labs., Bedford, Mass. California Inst. of Tech., Pasadena). Bull. Seismol. Soc. Amer.; 61: No. 6, 1589-1623(Dec 1971).

The mechanisms of generation of seismic waves by an explosion in prestressed media were studied using both field seismograms and controlled laboratory experiments. LRSM seismograms from the underground nuclear explosion Bilby were analyzed to determine the source parameters from the radiated Love and Rayleigh waves. From the normalized amplitudes of Rayleigh waves as well as the Love–Rayleigh amplitude ratios, a composite source consisting of an isotropic explosion and a double couple is synthesized for the explosion and the associated tectonic strain release. From Bilby and other explosions studied by similar techniques, it was found that the tectonic strain energy release strongly depends on the medium properties in the immediate vicinity of the explosion. For "harder" media (such as granite) the tectonic strain energy release and the relative amplitude of Love waves are significantly higher than for softer media such as alluvium. Source-time functions of Love waves associated with the explosions are closer to time functions of earthquakes than to those of explosions. The mechanisms of the pre-existing strain energy release by explosive sources are studied in two separate laboratory experiments. In a one-dimensional experiment where an explosive source is detonated in a rod stressed in torsion, the S-wave amplitudes are found to be linearly proportional to pre-

strain. In the second experiment, radiation of seismic waves and the near-source phenomena of explosive sources in prestressed plates are studied by photoelastic as well as strain gauge observations. The generation of S-waves is greatly enhanced by the prestress condition. It is found that extended cracking (faulting) occurs along directions determined by the prestress field. The transverse (SH) waves are generated primarily by the relaxation of the stress field along these cracks. The explosion-generated cavity alone could not account for the radiated transverse seismic energy. (auth)

12094 STRAIN ACCOMPANYING THE JORUM UNDERGROUND NUCLEAR EXPLOSION AND ITS RELATION TO GEOLOGY. Dickey, D. D. (Geological Survey, Denver). Bull. Seismol. Soc. Amer.; 61: No. 6, 1571-81(Dec 1971).

Precise geodetic surveys were made before and after the Jorum underground nuclear explosion, which was detonated September 16, 1969, at the U. S. Atomic Energy Commission's Nevada Test Site. Strains calculated from these surveys show a relationship of the strain directions and magnitudes to the volcanic caldera collapse system of this area. Strains within the area 20 collapse zone show northwesterly compression and are similar in magnitude, whereas strains in other collapse zones are generally smaller and of different orientations. Distance was monitored over a 2-km range from 5½ hr after the explosion to 5 days later. Five steplike distance changes were recorded during the first 4½ hr of monitoring and none was recorded after that. One of the steps was in conjunction with an identifiable seismic event. (auth)

12095 STATUS OF CURRENT TECHNOLOGY TO IDENTIFY SEISMIC EVENTS AS NATURAL OR MAN-MADE. A STAFF ANALYSIS OF THE TESTIMONY GIVEN AT HEARINGS BEFORE THE SUBCOMMITTEE ON RESEARCH, DEVELOPMENT, AND RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION ON EXTENT OF PRESENT CAPABILITIES FOR DETECTING AND DETERMINING NATURE OF UNDERGROUND EVENTS, OCTOBER 27 AND 28, 1971. Washington, D. C.; Joint Committee on Atomic Energy (1971). 40p. GPO $0.20.

A staff analysis of testimony given before the Joint Committee on Atomic Energy on Oct. 27 and 28, 1971 on current capabilities for detecting, locating, and identifying seismic events is presented. Included is information on current methods and instrumentation, possible future seismic systems, unmanned seismic detection systems, on-site inspection, and methods for evading detection of underground nuclear explosions. (L.C.L.)

12096 STATUS OF CURRENT TECHNOLOGY TO IDENTIFY SEISMIC EVENTS AS NATURAL OR MAN-MADE. HEARINGS BEFORE THE SUBCOMMITTEE ON RESEARCH, DEVELOPMENT, AND RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION, ON EXTENT OF PRESENT CAPABILITIES FOR DETECTING AND DETERMINING NATURE OF UNDERGROUND EVENTS, OCTOBER 27 AND 28, 1971. Washington, D. C.; Joint Committee on Atomic Energy (1971). 398p. GPO $1.50.

The Oct. 27 and 28, 1971 hearings before the Subcommittee on Research, Development, and Radiation of the Joint Committee on Atomic Energy on the status of current technology for detecting and identifying man-made and natural seismic events are reported verbatim. Nine witnesses gave prepared statements. Additional information from seismic experiments involving earthquakes and underground nuclear explosions is included. (L.C.L.)

12097 ANALYSIS OF TELESEISMIC SIGNALS FROM UNDERGROUND NUCLEAR EXPLOSIONS ORIGINATING IN FOUR GEOLOGICAL ENVIRONMENTS. Hasegawa, H. S. (Dept. of Energy, Mines, and Resources, Ottawa). Geophys. J. Roy. Astron. Soc.; 24: No. 4, 365-81(Dec 1971).

A comparison of Yellowknife records of the short-period teleseismic P codas of underground nuclear explosions with synthesized records enables one to differentiate between the primary signal and anomalous signal-generated noise. Primary signal refers to the P coda generated by a symmetric point source in a layered crust; both source and receiver crusts satisfy the requirements of the Haskell–Thomson matrix theory. For epicentral distances for which multipathing in the upper mantle does not occur, the large-amplitude phases in the first several cycles are dominated by the primary signal. Complexities in the next portion, which consists of smaller amplitude phases, are probably due to signal-generated noise resulting from the presence of lateral heterogeneities near the source such as faults and perturbations in layer thickness and composition. Finally complexities in the latter portion of the P coda may, in some cases, be due to explosion-generated noise resulting from the presence of topographical irregularities at greater distances from the source. Of the four geological environments studied, the events from Amchitka Island appear to have the smallest complexity factor and the event from Novaya Zemlya, the largest. The complexity of the events from the E. Kazakh site and the Nevada Test Site lies in between these two values. (auth)

12098 SOURCE-LAYERING FUNCTION OF UNDERGROUND EXPLOSIONS AND EARTHQUAKES. AN APPLICATION OF A COMMON PATH METHOD. Marshall, P. D.; Burton, P. W. Geophys. J. Roy. Astron. Soc.; 24: No. 5, 533(Dec 1971).

It is suggested that the difficulty of assessing the source-layering term of underground explosions and earthquakes can be overcome by means of the "common path" method. The source spectrum for atmospheric explosions was published by Carpenter and Marshall (1970) using data from the large explosions fired over Novaya Zemlya in 1962. Since 1964 large underground explosions have taken place very close to these epicenters. Since any two events which occur at the same epicenter have a common path parameter, this gives a means of relating the spectral source-layering functions for the two events. The common path method can be extended to earthquakes by using the known source-layering function. (UK)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 11504.

General Detectors and Monitors

Refer also to abstracts 12185, 12194, 12216, 12287, 12304, 12307, and 12313, 12330, 12388, 13385, 13407, 14080, 14225, 14469, and 14476.

12099 (BARC–552) DETERMINATION OF ABSOLUTE DISINTEGRATION RATES OF BETA–GAMMA EMITTERS. Ramaswami, A.; Dange, S. P.; Prakash, Satya; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 33p. Dep. NTIS (U. S. Sales Only).

The determination of absolute disintegration rates of beta emitters is of great importance in nuclear studies like decay schemes, cross section measurements, fission yield determinations, etc. Absolute disintegration rates of beta emitters were determined using $4\pi\ \beta$ and $4\pi\ \beta-\gamma$ coincidence counting techniques. Since these are not very convenient for day-to-day routine counting, gas-flow proportional counters, which are used for routine counting, were calibrated making use of the measurements made on $4\pi\ \beta$ and $4\pi\ \beta-\gamma$ coincidence counters. The efficiency of gas-flow beta proportional counters is now available for a number of fission-product nuclides. This report describes the details of these measurements. (auth)

12100 (EGG–1183-2264) EFFECTS OF THICKNESS, ABSORBED DOSE RATE, AND TOTAL DOSE ON PLASTIC SCINTILLATOR LIGHT EMISSION. Stevens, J.; Janee, H. S.; John, W. (EG and G, Inc., Goleta, Calif.). Jun 1971. Contract AT(29-1)-1183. 81p. Dep. NTIS.

For Los Alamos Scientific Lab., N. Mex.

The transient light emission of NE102 plastic scintillator was measured as a function of the energy per unit volume deposited in the scintillator for various values of scintillator thickness and exposure times. The results were compared to light emission from a Lucite Cherenkov radiator. At high absorbed dose rates the scintillators were found to become nonlinear, but the degree of nonlinearity was also found to depend on total dose. Thicker scintillators were found to display a greater degree of nonlinearity at the same value of absorbed dose rate; this effect was dependent on the total absorbed dose and may have been due to light attenuation. Because of the dependence in the relationship between absorbed dose and exposure dose on thickness, the threshold for nonlinearity in terms of exposure dose (in units of R/sec or γ-MeV/cm^2-sec) decreased rapidly as scintillator thickness increased. Consequently, the use of scintillators which are thin compared to an electron equilibrium thickness is recommended for gamma-ray intensity measurements. (auth)

12101 (EIR–195) DETECTOR OF FAST NEUTRON FLUX BASED ON THE REACTION ^{93}Nb(n,n')^{93m}Nb. Hegedues, F. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Mar 1971. 118p. (In French). Dep. NTIS (U. S. Sales Only).

A new detector of fast neutron flux is perfected. This detector uses the isomeric niobium production in the reaction ^{93}Nb(n,n'). The detector is very small, having a cross section practically independent of the energy and leading to a long-half-life isotope. The detector is better adapted to measurements of long lifetime in a reactor than those which are actually used. The cross section of the reaction ^{93}Nb(n,n')^{93m}Nb, the ratio of the conversion coefficients $\alpha K/\alpha$ of ^{93m}Nb and ^{103m}Rh, and the half-life of ^{93m}Nb were determined. (J.F.P.)

12102 (INR–1332) FISSION TRACK DETECTORS IN NEUTRON FLUENCE MEASUREMENTS. Jozefowicz, Krystyna (Institute of Nuclear Research, Warsaw (Poland)). 1971. 13p. Dep. NTIS (U. S. Sales Only).

Fission track detectors consisting of Makrofel polycarbonate foil and thick fissionable foils of thorium and natural and depleted uranium (bare or cadmium covered) were allowed to determine the fluence of fast, intermediate, and thermal neutrons. Several experiments are described concerning application of fission track detectors to reactor and Po-Be source neutron fluence measurements and to neutron accident dosimetry. (auth)

12103 (KFK–1461) WORK ON SOLID-STATE TRACK DETECTORS. Guenther, Gudrun (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Aug 1971. 30p. (In German). Dep. NTIS (U. S. Sales Only).

Investigations in preparation for routine application of solid state track recorders for measurements in SNEAK are described. A polycarbonate foil (Lexan) was chosen as a detector material satisfying all requirements. In this type of material fission products leave tracks which can be enlarged by etching until they are visible in a light microscope. A simple model of the etching process was compared to experimental results. In order to increase the contrast of the tracks against the background they were finally colored using a felt pen. The evaluation is performed with the image analyzer CLASSIMAT, an apparatus designed to count single particles. The operation of the CLASSIMAT was tested and calibration curves were taken. Using some experimental results the principle of operation was demonstrated. A modification of the CLASSIMAT is planned in preparation of a completely automated image analysis using a computer. (auth)

12104 (NP–19154) DEVELOPMENT OF A TRITIUM COUNTER WITH LOW BACKGROUND AND HIGH EFFICIENCY, AND ITS USE IN STUDIES ON THE SUPRARENAL CAPSULE AND TESTIS OF THE RAT. Parvinen, Martti (Turku Univ. (Finland)). 1971. 78p. (In Finnish). Dep. NTIS (U. S. Sales Only).

Thesis.

An automatic, internal sample, metal cathode gas counter with low background and high efficiency was developed for the microdetermination of tritium β in biological samples. Tritium was converted into gas form by combustion of samples in sealed Pyrex-glass ampoules at 640°C for one hour. A background of 0.5 cpm was achieved, when the volume of the counting tube was reduced to 10 cm^3 and the detector was surrounded by a plastic scintillator. The proportional counter and plastic shields were placed within thick metal shielding, and a counting tube was designed with optimal geometry to minimize end wall effect and background. For tritium β a counting efficiency of 57.4 ± 2.1% was achieved, which was not influenced by biological samples weighing up to 2 mg. Activities down to 2 pCi (4 dpm) with a standard deviation of ±16% were detected by using one hour counting time. This was 100 times higher than that obtained using liquid scintillation counting. The memory effect after measurement of 500 cpm activities was 0.6% after a single flushing with methane, 0.1% after repeated flushing, and after three flushings no detectable memory effect was present. The instrument was used for the quantitative evaluation of tissue distribution of β radioactivity in the rat adrenal cortex after injection of tritiated steroids. (103 references). (TSS) (Finland)

12105 SMALL ALPHA MONITOR USING A SURFACE BARRIER DETECTOR. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Phys.; 22: No. 1, 99-102(Jan 1972).

A portable monitor using a 450 mm^2 surface barrier detector is described. An audible tone generator provides a short sound pulse whenever an α particle is detected. A 6 volt output pulse was also available. When the discriminator was set so that particles losing less than 1 MeV in the junction of the detector were ignored, the efficiency for α-emitters (Am) was 30% and for β-emitters 0.03%. The background counting rate due to α activity in and around the detector was about 6 counts/hr. (UK)

12106 STANDARDIZATION OF NUCLEAR MEDICINE INSTRUMENTATION. Cradduck, T. C. (Toronto General Hospital). Phys. Med. Biol.; 16: No. 4, 701-2(Oct 1971).

It is pointed out that the demands of clinical instrumentation may be different from those of the nuclear high energy physicist, and that manufacturers should therefore not be forced to build solely to NIM specifications. It is usual in nuclear medicine to perform one type of study with a particular apparatus, and the versatility of the more expensive NIM modular systems is therefore of no great value. In his reply, Lavoie refutes these arguments; the success of the NIM and CAMAC standards is cited and NIM cost comparisons briefly discussed. (UK)

12107 SUGGESTION FOR RADIATION SAFETY IN THE USE OF X-RAY DIFFRACTION EQUIPMENT. Trout, E. D. (Oregon State Univ., Corvallis). Health Phys.; 22: No. 1, 94(Jan 1972).

A modification was made to Victoreen Instrument Co. Vamp Area Monitor (Model 808B). Provision was made for a remote detector of low level, low energy x rays. The modification was based on measurements indicating that at 50 kVp, 1 mA, and with a beam of area 1 cm^2, the air scatter at a distance of 1 m from the beam and at 90° to the beam would result in a rate of 0.25 mR/hr. The design provided for a distance of 10 ft between the

detector and the monitor, and deactivation of a safety component or removal of shielding resulted in an audible alarm. (UK)

12108 RADIOISOTOPE INSTRUMENTS. PART 1. Cameron, J. F.; Clayton, C. G. Oxford; Pergamon Press (1971). 319p. £8.50.

The subject is dealt with under the following headings; introduction (the physical basis of radioisotope instruments, technical advantages of radioisotope instruments, economic advantages of radioisotope instruments, some characteristics of radioisotope instruments and radiation hazard); commercial radioisotope instruments (radiation sources and detectors, measuring heads, indicating units and computing and control units); applications of radioisotope instruments in industry (advantages of radioisotope instruments, summary of the uses of radioisotope instruments, agriculture, forestry and fishing, mining and quarrying, the manufacturing industries, civil engineering constructions, electricity, gas, water and sanitary services, research, services, transport and communications); health and safety, legal requirements and insurance (radiation hazard and its control, legislation and codes of practice governing the use of sealed radioisotope sources); and insurance of sealed radioisotope sources and installations. (UK)

12109 CORRECTION FACTORS FOR 9- AND 10-IN. SPHERE NEUTRON INSTRUMENTS AND 1-IN.-DIA. BARE BF_3 TUBES USED TO MONITOR SMALL BEAMS AND SLITS. Hankins, Dale E.; Neely, Glenn W. (Los Alamos Scientific Lab., N. Mex.). Health Phys.; 22: No. 1, 65-71(Jan 1972).

Correction factors for the 9-in. cadmium-loaded monitor, for the 10-in. sphere neutron monitor (remmeters), and for a 1-in.-dia bare BF_3 tube are given for square beams with sizes ranging from 1 to 10 in., for slits $\frac{1}{4}$ to 10 in. wide and for partial beams from 2 to 10 in. wide. (auth) (UK)

12110 THEORETICAL ANALYSIS OF PROPORTIONAL COUNTER RESPONSE VERSUS LET. Martin, George G.; Smathers, James B.; Neff, R. D. (Texas A and M Univ., College Station). Health Phys.; 22: No. 1, 73-7(Jan 1972).

A study was made of the characteristics of proportional counter response versus LET in order to determine the variations in this response with changes in the size of the sensitive volume of the counter and/or the discriminator setting. A computer program was developed to couple the energy distribution and LET equations of five beta emitters, ^{41}Ar, ^{85}Kr, ^{131}I, ^{133}Xe and ^{137}Cs, for detector chamber sizes of $50 \times 10 \times 1$ cm, $50 \times 10 \times 4$ cm and $50 \times 10 \times 10$ cm. The data yielded a set of response curves which indicated that the changes mentioned above could significantly alter the detection capabilities of the instrument. Using ^{85}Kr as a calibration standard and depending upon the chamber dimensions, results of the calculations showed that only 58 to 77% of the ^{41}Ar which entering the chamber could be detected when the discriminator is set for detection of 90% of the ^{85}Kr entering the chamber. For the same conditions, 100% of the ^{131}I, ^{133}Xe and ^{137}Cs could be detected. It is concluded that a proportional counter calibrated with a standard beta emitter should not be indiscriminately used for detecting other isotopes unless a correction is made for instrument response variation. (auth) (UK)

12111 NUCLEAR PARTICLE DETECTORS MADE BY ION-IMPLANTATION. Mattsson, C.-G.; Holmen, G. (Chalmers Univ. of Tech., Goteborg). Phys. Scr.; 3: No. 3-4, 101-2(1971).

The fabrication and characteristics of ion-implanted semiconductor detectors are described. An energy resolution of 13 keV was obtained for cooled detectors and a resolution of 21 keV was obtained at room temperature. (W.H.K.)

12112 IMPROVEMENTS IN OR RELATING TO RADIATION DETECTION SYSTEMS. Tunnicliffe, Michael John (to Electronic and X Ray Applications Ltd). British Patent 1,258,902. 30 Dec 1971. Filed 5 Mar 1968.

Reference is made to radiation detectors of the kind in which a number of detectors are arranged in the form of a matrix, to enable records of radiation levels to be made at a number of points. The system is described particularly in relation to use in the location of brain tumors and similar disorders, but is also capable of more general application. The object is to provide a method of mounting the detectors, for example on a patient's head, in such a way as to reduce the disadvantages of previous methods. Each detector is removably mounted within a longitudinally extending metal tubular member, the detectors being assembled with their longitudinal axes parallel and with their outer walls making line contact with one another. A collimator may be provided in each tubular member, and each detector may include a scintillation crystal and photoelectron multiplier to form a single assembly. The tubular members may be retained in position by a sheet metal surround, with a Pb layer between these members and the surround. (UK)

12113 CALIBRATION OF DOSIMETERS AND FLOW METERS USING X-RAYS UP TO 300 keV. Drexler, G.; Gossrau, M. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). pp 110-15 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In German).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The different types of filters used in conjunction with x-ray tubes (anode potentials of 40, 60, 80, 100, 120, 150, 200, 250 and 300 kV) to produce almost monoenergetic radiation suitable for calibration purposes are discussed. The Ge(Li) spectrometer used, and the methods adopted to make the measurements are described. A graphic method, which enables the spectra of the different radiations to be simply and accurately reproduced in the form of approximations to a gaussian distribution, is presented. (France)

12114 ENERGY INDEPENDENT EXPOSURE METER UP TO VERY LOW PHOTON ENERGY WITH HIGH ACCURACY AND SENSITIVITY. Zsdanszky, K.; Hizo, J. (National Office of Measures, Budapest). pp 123-6 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

An accurate and very sensitive apparatus suitable for measurements with various energy radiations (x or γ radiations) is described. This apparatus may be used to standardize instruments used in radioprotection or for dose measurements in radiotherapy with x or γ radiations. (France)

12115 THIN CRYSTAL MOSAIC DETECTOR FOR IN VIVO MEASUREMENTS. Andrasi, A.; Feher, I.; Lendvay, J. (Hungarian Academy of Sciences, Budapest). pp 154-8 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The properties of a thin crystal mosaic detector with a 400 cm^2 sensitive surface, developed for human in vivo counting of low energy photons, were investigated. The characteristics of the equipment: resolving power, counting efficiency, and background were measured. The counting efficiency of the mosaic detector for activities deposited in the lung was determined using a computer and a simple mathematical model. The computer results were checked by measurements made with a point source. The design of a scanning bed and 4π counting equipment incorporating several mosaic detectors is discussed. A mathematical model for evaluating the sensitivity and minimum detectability of some important isotopes is described, which assumes a ring of six mosaic detectors. (France)

12116 COINCIDENCE METHOD FOR ABSOLUTE MEASUREMENT OF INCIDENT ENERGY OF ELECTRONS. Bhattacharya, P. K.; Bhiday, M. R. (S.G.S. Inst. of Tech. and Science, Indore, India). Indian J. Phys.; 44: No. 4, 258-63(Apr 1970).

A coincidence method is devised for absolute measurement of energy of electrons up to 5 MeV. The method makes use of the fact that the angle between the scattered and recoil particles is dependent on the relativistic energy of the incident electrons. Using fast coincidence techniques and a fast multiparameter analysis system in conjunction with fast directional scintillators like "Phoswich" to detect the two particles, the method can be made accurate to ±1%. Employing thin foil targets, multiple scattering ($Z \simeq 6$) and hence, the angular spread in the coincidence peak becomes small. Thus, it is possible to measure the beam energy at the target simultaneously with the scattering cross-section without the necessity of making any change in the experimental set-up. (auth)

12117 HIGH-EFFICIENCY NEUTRON DETECTOR. Sanin, I. V.; Markov, G. N.; Krivenko, A. I.; Ivchenko, N. G. At. Energ. (USSR); 31: No. 6, 635-6(Dec 1971). (In Russian).

Neutrons were detected by means of recording the Cherenkov radiation generated by deceleration of the neutrons in a solution of NaCl in water. Measurements of an intense gamma background

of about 0.5 MeV were necessary because of the water present. The dependence of sensitivity of the Cherenkov detector on the energy of gamma quanta was studied; recording of neutrons from a Pu–Be source was 100× more sensitive than the response to ^{60}Co or ^{137}Cs gamma radiation. (K.S.W.)

12118 EVENT SIMULTANEITY IN CAVITIES. THEORY OF THE DISTORTIONS OF ENERGY DEPOSITION IN PROPORTIONAL COUNTERS. Kellerer, Albrecht M. (Columbia Univ., New York). Contract AT(30-1)-2740. Radiat. Res.; 48: No. 2, 216-33(Nov 1971).

The so-called wall effects are distortions of the statistics of energy deposition which occur in proportional counters even if the counting gas and the counter walls have the same atomic composition. The distortions are due to the density difference between walls and counting gas. They consist in the simultaneity of particle passages which in the case of uniform density would occur separately. For heavy particles the delta-ray effect is dominant, but the V-effect can be significant at very high energies of the primary particles. In the case of x-rays, γ-rays, and fast electrons the distortions are due to the reentry, or backscattering, effect. Numerical estimates for the extent of the different processes and the corresponding change of mean event size and of event frequency are given. (auth)

12119 LOW SPECIFIC β ACTIVITY MEASUREMENTS. Chereji, I. (Inst. of Atomic Physics, Cluj). Stud. Cercet. Fiz.; 23: No. 6, 719-35(1971). (In Rumanian).

Topics include counting parameters, counting rates of gas and scintillation counters, and low-background attainment (cosmic background and secondary effects). The electronics and electrical system are discussed, and methods for sample enrichment are considered. (auth)

12120 RADIOLUMINESCENCE FLASH IN KI(Eu) PHOSPHOR. Varenko, G. D.; Avdonin, V. P.; Plachenov, B. T. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 3, 263-5(Mar 1971).

Translated from Opt. Spektrosk.; 30: No. 3, 479-83(Mar 1971).

The temperature conditions for the formation of and spectral composition of low-temperature radioluminescence flash in KI–Eu were studied. An interference concerning the sign of the activator-recombination luminescence in the radioluminescence process was made. (auth)

12121 ENVELOPE FOR A SEMICONDUCTOR RADIATION DETECTOR. Meuleman, Johannes; Aussant, Michel (to La Radiotechnique Compelec). French Patent 2,060,263. 18 Jun 1971. Filed 24 Sep 1969. (In French).

A sealed envelope, consisting of a supporting box with a lid, houses the crystal semiconductor of a radiation detector. At least one of the faces is provided with a radiation input window. The window is constructed of a ceramic material and vacuum sealed. The ceramic used is very transparent to radiations and easily machinable; thus a very thin window of minimum absorbance presenting a very good vacuum sealing is obtained. Furthermore, because the mass of metal exposed to the radiations is reduced to that of the contact area, backscattering and secondary emission of the radiations are eliminated, or at least strongly attenuated. (auth)

12122 DEVICE FOR POSITIONING THE CRYSTAL OF A SEMICONDUCTOR RADIATION DETECTOR. Meuleman, Johannes (to La Radiotechnique Compelec). French Patent 2,060,264. 18 Jun 1971. Filed 24 Sep 1969. (In French).

A device for positioning the semiconductor crystal of a radiation detector in a sealed envelope, consisting of a box with a lid, is described. The crystal consists of two coaxial regions of opposite type semiconductor, (separated if necessary by an intrinsic region), between which the detecting junction is formed. The device consists of a metallic or insulating casing, which is fixed to the box and encloses the crystal. This casing may either be in the form of two shells assembled by a tightening system, or a slit tube constructed of an elastic material, or a can. The box which serves to form an enclosure, and not to ensure the positioning of the crystal, may consequently be very thin. The lid may contain an entry window for the radiation, which limits the absorption and backscattering. (France)

12123 DEVICE FOR POSITIONING THE CRYSTAL OF A RADIATION DETECTOR INSIDE AN ENVELOPE. Meuleman, Johannes (to La Radiotechnique Compelec). French Patent 2,060,265. 18 Jun 1971. Filed 24 Sep 1969. (In French).

A device for positioning the semiconductor crystal of a radiation detector in a sealed envelope (consisting of a box with a cover) is described. The crystal possesses a hole about which the detecting junction is situated between two different semiconductor type regions, separated if necessary by an intrinsic region. The device consists of a rigid rod connected to the box which is forced into the hole in the crystal. This rigid rod may be connected to a platform fixed to the box, or to the box itself; it may be metallic or insulated, depending under what temperature conditions it is to be used; if the tube is hollow it can carry the connecting wire. (France)

12124 AUTOMATIC SAMPLE CHANGEOVER DEVICE. Fremion, Lucien (to Commissariat a l'Energie Atomique). French Patent 2,061,508. 25 Jun 1971. Filed 27 Feb 1969. (In French).

An automatic sample changeover device for analysis by gamma spectrometry is described; it is principally designed for small volume bottles containing active solutions. The selection of a bottle containing a given sample from an assembly of bottles in a stock is ensured. This sample is brought to the measuring equipment, which consists of a crystal scintillator associated with a multichannel amplitude selector, and removed after the counting to a recovery place. The device consists of a horizontal table, which rotates about a perpendicular axis, and contains a number of equally spaced sample holes for the bottles containing the substances to be analyzed. (France)

12125 PROPOSED ANSI STANDARD FOR THE SPECIFICATION OF PORTABLE X OR GAMMA RADIATION SURVEY INSTRUMENTS. ANSI N13.4 1970. New York; American National Standards Institute (1970). 11p.

A standard prescribing specifications for portable x or gamma radiation survey instruments is presented. (W.H.K.)

12126 NEUTRON DETECTOR. Chernyayev, V. B.; Sokolova, Z. Ya. (to Ioffe Inst. of Physics and Tech.). Russian Patent 288,172. 3 Dec 1970. Filed 31 Jul 1969. (In Russian).

A neutron detector in the form of a moderator light guide inside of which are coaxial cavities with a scintillating material is described. The moderator light guide is covered by a reflector. The effectiveness of neutron registration is improved by forming the cavities with surfaces of truncated cones having an identical central solid angle at the exit pupil of the detector, while the surface of the moderator light guide is in the shape of a hemisphere. (JPRS)

12127 IDENTIFICATION OF ENERGETIC HEAVY NUCLEI WITH SOLID DIELECTRIC TRACK DETECTORS: APPLICATIONS TO ASTROPHYSICAL AND PLANETARY STUDIES. Price, P. B. (Univ. of California, Berkeley); Fleischer, R. L. Annu. Rev. Nucl. Sci.; 21: 295-334(1971).

Background information on current methods of particle identification by means of dielectric track detectors is given, and the advances in knowledge of the composition of galactic and solar energetic nuclei made by using the unique features of these nuclei are discussed. Track formation and elements of particle identification from track geometry are considered. Specific detectors may be made of plastic (e.g., lexan polycarbonate, cellulose nitrate, cellulose triacetate, or cellulose acetate butyrate), glass, or minerals. Data on the composition of present-day and ancient galactic cosmic rays and of energetic solar flare particles are then presented. The use of these detectors in the search for particles with magnetic charge and in identification of products of nuclear reactions is discussed. (16 figures, 1 table, 172 references) (R.W.R.)

12128 TEST PROCEDURES FOR GERMANIUM GAMMA-RAY DETECTORS. IEEE Std 325 1971. New York; Insitute of Electrical and Electronics Engineers, Inc. (1971). 19p.

A standard specifying test procedures for measuring germanium detector characteristics, energy resolution, counting efficiency, and timing is presented. These test procedures are a supplement to the following documents: IEEE Std. 300-1969, Test Procedures for Amplifiers and Preamplifiers for Semiconductor Radiation Detectors, (ANSI N42.1-1969) and IEEE Std. 301-1969, Test Procedure for Amplifiers and Preamplifiers for Semiconductor Radiation Detectors, (ANSI N42.2-1969). (W.H.K.)

12129 EFFECTS OF EVACUATION AND CHEMICAL SENSITIZATION ON SENSITIVITY TO X-RAYS AND γ-RAYS. Lewis, W. C.; Babcock, T. A.; James, T. H. (Eastman Kodak Co., Rochester, N. Y.). Photogr. Sci. Eng.; 15: No. 3, 209-12(May-Jun 1971).

Exposures of monodisperse AgBr emulsions of 0.2-μ grain size were made in room air and after evacuation to 80- and 250-kV x-rays and to Co-60 γ-rays. Evacuation, reduction, sensitizing, and sulfur-plus-gold sensitizing had negligible effect on the sensitivity to 80-kV x-rays, but increased sensitivity to 250-kV x-rays and γ-rays. Results with the 80-kV

x-rays can be explained on the basis that a single quantum hit makes a single grain developable. Additional grains are affected by the higher-energy quanta. Centers of near threshold size are formed in at least some of these grains, where the effects of chemical sensitization, or of prevention of loss of electrons to oxygen, can change the probability of a grain becoming developable. Sulfur sensitization resulted in a decrease in sensitivity for all three exposures, attributable to increased dispersity of radiolytic silver. Evacuation increased the sensitivity of the sulfur-sensitized emulsion for all exposures. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 11554 and 14260.

12130 (INR–1314) SYSTEM FOR STABILIZING THE SPECTRUM OF FISSION FRAGMENTS. Nadachowski, Michal (Institut of Nuclear Research, Warsaw (Poland)). 1971. 26p. (In Polish). Dep. NTIS (U. S. Sales Only).

A system for stabilizing the spectrum of fission fragments is described. The theoretical calculations of the stabilizing factor and the results of measurements are given. (auth)

12131 (IRI-133-71-6) GAMMA RAYS FROM ISOTOPES PRODUCED BY (n,γ)-REACTIONS. de Bruin, M.; Korthoven, P. J. M. (Interuniversitair Reactor Instituut, Delft (Netherlands)). [1970]. 112p. Dep. NTIS (U.S. Sales Only).

The gamma ray spectra were measured from 0.1 to 2 MeV for the relevant natural isotopes for the use of semiconductor detectors in nondestructive activation analysis. Tables for the energies and relative intensities of these gamma rays are given. (J.F.P.)

12132 (LA-DC–12854) YET ANOTHER PHOTOPEAK ANALYSIS PROGRAM FOR THE PDP-9 COMPUTER. East, Larry V. (Los Alamos Scientific Lab., N. Mex.). [1971]. 8p. (CONF-711126–1). Dep. NTIS.

From DECUS Fall symposium; San Francisco, Calif. (11 Nov 1971).

A FORTRAN program written to perform analysis of high resolution gamma-ray and x-ray pulse height spectra on a PDP-9 computer is described. Data to be analyzed are obtained from DEC-tape, and the data regions to be analyzed are chosen using a light-pen and large screen display. The program will fit up to three Gaussian functions plus linear or exponential background terms to spectral peaks using the method of nonlinear weighted least-squares. An iterative method involving the second order expansion of the fitting function is used to obtain the fit parameters, rather than the more common Gauss procedure. (auth)

12133 ANALYSIS OF OBSERVED GRAIN DENSITY IN NUCLEAR EMULSIONS. Gaur, R. K.; Sharma, A. P. (Kurukshetra Univ., India). Indian J. Phys.; 44: No. 5, 308-18(May 1970).

Actually observed grain density along the tracks of the charged particles in nuclear emulsions is analyzed in terms of primary, secondary, and fog grains. An attempt is made to estimate the contribution of the primary and secondary-grain densities theoretically for various values of velocities. The results of our model are compared with those of previous authors. It is concluded that the secondary grain density accounts for nearly 33.5% of the total grain density observed in G-5 emulsions for $0.08 < \beta < 0.14$ and 23%, at minimum ionization. The theoretical results agree well with the experimentally observed values. (auth)

12134 DEAD TIME CORRECTION FOR GAMMA-RAY SPECTROSCOPY. Filippone, W.; Munno, F. J. (Univ. of Maryland, College Park). Nucl. Sci. Eng.; 47: No. 1, 150-62 (Jan 1972).

In a discussion of the interpretation of the data obtained by a multichannel analyzer from a sample containing mixed gamma-ray emitting isotopes, it is concluded that dead time losses influence both the magnitude and shape of the composite spectrum. A relation including appropriate corrections is presented. (auth)

12135 FAST COMPUTER ANALYSIS OF THE γ SPECTRUM FROM Ge(Li) DETECTORS. Baba, Hiroshi; Okashita, Hiroshi; Baba, Sumiko; (and others) (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 12, 703-12 (Dec 1971).

A method for rapidly analyzing the γ spectrum obtained with Ge(Li) detectors was developed for a medium-size electronic computer. The analysis is based on the first derivative method, associated with a number of peak-shape tests. The effects of data smoothing and of changes in peak width were studied to determine the optimum conditions for spectrum analysis. The resulting computer program was subjected to various quality tests on the predicted values of the peak position and area. The results of the tests showed that the code thus developed works quite satisfactorily. The code requires 10 sec and a memory core of 29 k when using a FACOM 230-60 for the analysis of a 2,047 channel spectrum. (auth)

12136 SPECTROMETRIC METHOD FOR MEASURING LOW ENERGY BREMSSTRAHLUNG. Drexler, G.; Perzl, F. (Gesellschaft fuer Strahlen und Umweltforschung mbH, Neuherberg, Ger.). pp 102-9 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In German).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Spectrometric methods, particularly suitable for bremsstrahlung measurements, are described. The 10 to 300 keV energy range is considered. A new method using Ge semiconductor detectors is described in detail. (France)

12137 OPTIMUM ENERGY GAPS OF A SCINTILLATION GAMMA SPECTROMETER. Novikov, G. F.; Sinitsyn, A. Ya.; Kozynda, Yu. O. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 98-106(1969). (In Russian).

Based on experimental work with U and Th gamma radiation spectra, measured with NaI(Tl) crystals 40 × 50, 30 × 25, and 18 × 30, energy windows are recommended for the spectrometer for testing complex radioactive ores which assure minimum statistical and equipment error in the determination of U and Th. For the first window, 300 or 700 keV is recommended for the lower level in the range of 1,040 to 1,120 keV. For the second window, 600 keV is recommended for the lower level near 2,000 keV. For crystals greater than 50 cm^3 in volume, there is recommended in addition a first window 200 or 300 keV in width for a low level near 1,600 or 1,500 keV, respectively. (tr-auth)

12138 DEPENDENCE OF OUTPUT PULSE OF A SCINTILLATION COUNTER ON CRYSTAL WINDOW AND PHOTOCATHODE AREAS. Damitov, B. K. At. Energ. (USSR); 31: No. 6, 637-9(Dec 1971). (In Russian).

In resolving certain problems in gamma spectrometry it is required to connect a photomultiplier of small diameter with a scintillator having a large exit window. Experimental results with a ^{137}Cs source show that for a significant decrease in the photocathode diameter and a fixed output window area of the crystal, the amplitude of the issuing pulses is significantly decreased and becomes comparable with the internal noise of the photomultiplier. (K.S.W.)

12139 OPTIMUM ENERGY WINDOWS OF A SCINTILLATION GAMMA-SPECTROMETER. Novikov, G. F.; Sinitsyn, A. Ya.; Kozynda, Yu. O. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 98-106 (1969). (In Russian).

On the basis of an analysis of experimental spectra of gamma radiation from U and Th, measured by NaI(Tl) crystals of different sizes, recommendations are made concerning the energy windows of the spectrometer for assaying complex radioactive ores that will guarantee minimum statistical and instrumental error in determining U and Th: 300 or 700 keV for the first window in the case of a lower level in the range 1040 to 1120 keV, and 600 keV for the second window in the case of a lower level around 2000 keV. In addition, for crystals more than 50 sq cm in size, the first window should be 200 or 300 keV wide for a lower threshold around 1600 or 1500 keV, respectively. (Geophys. Abstr.)

12140 RECENT ADVANCES IN DESIGN OF MAGNETIC BETA-RAY SPECTROMETERS. Mladjenovic, Milorad S. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Advan. Electron. Electron Phys.; 30: 43-77(1971).

Topics include flat spectrometers with cylindrical field (semicircular spectrometers, $\pi\sqrt{2}$ spectrometers, $(\pi/2)\sqrt{13}$ spectrometer, $\pi\sqrt{10}$ spectrometer, and winding field spectrometer); sector spectrometers; toroidal (orange) spectrometers; lenses; trochoidal spectrometers; optical analogy spectrometer (dispersion, aberrations and resolution, deflecting magnet, and magnetic lenses); correctors (multistrip source and second-order correctors); and azimuthally varying field. Also, the performance parameters of various types of magnetic beta spectrometers are compared. (W.H.K.)

High Energy Physics Instrumentation

Refer also to abstracts 13881, 13906, and 13917.

12141 (JINR–P13-6114) RESULTS OF INVESTIGATION OF CHARACTERISTICS OF PROPORTIONAL CHAMBERS. Zanevskii,

Yu, V.; Peshekhonov, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The construction and properties (obtained under laboratory conditions) of the proportional chambers with 2 and 3 mm wire spacing of a signal plane are described. A sensitive area of the chamber is 150 × 150 mm^2. These chambers have successfully been used for selective triggering of the wire spark chamber system in the π^-p elastic scattering experiment at the Institute of High Energy Physics (Serpukhov). (auth)

12142 (TID-25874, pp 27-37) VECTOR-MESON AND MISSING-MASS PHOTOPRODUCTION USING A TAGGED-PHOTON BEAM AT NAL. Tannenbaum, M. J. (Harvard Univ., [Cambridge], Mass.). 1970.

In 1970 summer study.

Means by which the detector proposed for muon inelastic scattering could also be used to perform a significant photoproduction experiment are discussed in detail. It is proposed to study vector-meson photoproduction and search for other bosons via missing-mass methods in the energy range 30 to 100 GeV by using a tagged-photon beam of 10^5/pulse with ± 1% resolution. The detector is a large-aperture magnetic spectrometer in the forward direction and two wide-angle, proton-recoil, pulse-height spectrometers. Wire spark chambers are used throughout. The counting rate is 250,000 detected ρ^0 mesons and an estimated 60,000 events in the missing-mass range 1.2 to 4.0 GeV per day. Since the apparatus described is essentially identical to the Harvard muon proposal, it could be used for both experiments with minor modifications if a tagged-photon beam and a muon beam could both be brought down the same beam line. (auth)

12143 (TID-25874, pp 45-74) RECENT DEVELOPMENTS IN HIGH-RESOLUTION NOBLE-LIQUID COUNTERS. Derenzo, Stephen E.; Smith, Dennis B.; Smits, Robert G.; Zaklad, Haim; Alvarez, Luis W. (California Univ., [Livermore]. Lawrence Radiation Lab.); Muller, Richard A. (California Univ., Berkeley. Space Sciences Lab.). 1970.

In 1970 summer study.

In an effort to develop a liquid-filled high-resolution wire chamber, the multiplication of ionization electrons was studied in liquid argon and liquid xenon near the surface of fine wires from 3.5 to 13 μ in diameter and near etched tungsten tips from 1 to 2 μ in diameter. The pulse height and shape depend on the applied voltage and (in liquid argon) on the hydrostatic pressure. The pulses are 10^{-12} to 10^{-10} coulombs in size with a rise time of 5 to 10 μs in liquid argon and <5 ns in liquid xenon. By using a 3.5-μ tungsten wire in very pure liquid xenon, a charged-particle detection efficiency greater than 30% and a time resolution of 100 ns was obtained. In addition, a 3.5-μ wire in liquid xenon acts as a dc spark counter, delivering pulses 100 ns wide and 5 to 10 V high into a 50-ohm load. With somewhat larger wires or when liquid argon is used, electron avalanching is unreliable and occurs at places only sparsely distributed along the length of the wire. In order to develop a practical high-resolution counter, conducting strips attached to a dielectric substrate are proposed. It is even possible to deposit a row of sharp points on each conducting strip. A new scheme that should be capable of automatically reading out thousands of closely spaced conductors is also presented. (auth)

12144 (TID-25874, pp 75-84) INTEGRATED-CIRCUIT READOUT FOR CLOSELY SPACED WIRE ARRAYS. Zaklad, Haim (California Univ., [Berkeley]. Lawrence Radiation Lab.). 1970.

In 1970 summer study.

Some of the recent advances in solid-state circuitry which permit the readout of large arrays of closely spaced wires are reviewed. Charges as small as 10^{-13} coulomb can be read from lines spaced 63 microns apart. Projected chip cost is 30 cents/line. (auth)

12145 (TID-25874, pp 85-101) DISC COUNTERS. Meunier, R. (European Organization for Nuclear Research, Geneva (Switzerland)). 1970.

In 1970 summer study.

Features and design criteria of DISC counters are discussed. Examples of designs extrapolated for the new energy range are given. (auth)

12146 (TID-25874, pp 103-8) THRESHOLD CERENKOV COUNTERS AT NAL. Pruss, S. (National Accelerator Lab., [Batavia], Ill.). 1970.

In 1970 summer study.

Design features of threshold Cherenkov counters at NAL are discussed, and a possible set of counters for identifying pions, kaons, and antiprotons up to 200 GeV/c beam momenta are presented. (auth)

12147 (TID-25874, pp 109-13) HIGH-RESOLUTION DETECTORS AT NAL. Atac, M. (National Accelerator Lab., [Batavia], Ill.). 1970.

In 1970 summer study.

A detector development program has started at NAL. High-resolution multiwire proportional chambers and spark chambers are being developed. (auth)

12148 (TID-25874, pp 161-3) VERTEX DETECTORS EMPLOYING MAGNETIC FIELDS ALONG THE BEAM AXIS. Meyer, D. I. (Michigan Univ., Ann Arbor). 1970.

In 1970 summer study.

Calculations show that a "solenoidal" geometry (magnetic field along the incoming beam direction) has a number of advantages over more conventional geometries for a vertex detector. The detectors themselves are no more difficult to build than those for a conventional geometry, and the magnet, while large, is not prohibitive in cost and is probably competitive with those employing other geometries. (auth)

12149 (TID-25874, pp 169-71) HYBRID SPECTROMETER FOR ANALYZING INELASTIC REACTIONS WITH A SINGLE HIGH-MOMENTUM SECONDARY. Panvini, R. (Brookhaven National Lab., Upton, N. Y.). 1970.

In 1970 summer study.

A streamer chamber with an internal hydrogen target along with a single-armed spectrometer downstream should be a very good way to analyze inelastic reactions with only one high-momentum charged secondary. The remaining particles will have low momentum, by momentum conservation, and only a moderate-sized streamer chamber (~1 meter) will be required to measure the secondaries at the target vertex. (auth)

12150 (TID-25874, pp 279-80) MUON DETECTION WITH A PLATE INSIDE THE 15-FT NAL BUBBLE CHAMBER. Palmer, Robert (Brookhaven National Lab., Upton, N. Y.). 1970.

In 1970 summer study.

The use of a thick metal plate inside the 15-ft bubble chamber is considered for the detection of muons, the alternative being a system of plates and counters placed outside the bubble chamber. In either case, a track is identified as a muon if it passes through the plate and is detected on the other side. No identification can result if the track does not pass through the plate. False identification arises if the track, being a pion, decays unobserved in flight, and the resultant muon is seen to pass through the plate; or if the track, being a hadron, makes an interaction in the plate, but a secondary emerges in the forward direction; or, of course, if the initial hadron makes no interaction and emerges. These difficulties are considered, the plate inside is compared with a plate outside the chamber. (auth)

12151 (TID-25874, pp 281-2) NEUTRINO-ENERGY ESTIMATES IN A Ne BUBBLE CHAMBER. Cline, D. (Wisconsin Univ., [Madison]). 1970.

In 1970 summer study.

If the NAL bubble chamber is filled with Ne and events are restricted to a small fiducial volume upstream in the bubble chamber, it should be possible to measure the average energy of the incident neutrino to ~6% and to identify muons in the final state on a statistical basis. Because of the large mass available and the possibility of making E_ν estimates entirely within the bubble chamber, the Ne bubble chamber should provide a powerful tool in the early exploration of ν_μ interactions at NAL. (auth)

12152 (TID-25874, pp 283-94) PROPORTIONAL QUANTAMETER FOR THE 15-FOOT BUBBLE CHAMBER. Yount, D. (Hawaii Univ., Honolulu). 1970.

In 1970 summer study.

The performance of a proportional quantameter to detect and measure the energy of the neutral pions produced by neutrino interactions in the 15-foot bubble chamber is evaluated. The total energy is determined from the sum of a number of wire outputs, while spatial resolution is obtained by reading out other wire planes individually. (auth)

12153 (TID-25874, pp 295-302) EXTERNAL VERSUS INTERNAL MUON IDENTIFICATION IN THE 15-FOOT BUBBLE CHAMBER. Mukhin, A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii); Yount, D. (Hawaii Univ., Honolulu). 1970.

In 1970 summer study.

Two methods for identifying muons from neutrino interactions in the 15-foot bubble chamber are compared: the first uses a 1-m thick lead plate inside a neon filling, and the second uses optical spark chambers interspersed with walls of concrete external to the bubble chamber. (auth)

12154 (TID-25874, pp 303-13) OBSERVATIONS ON THE USE OF A TRACK-SENSITIVE TARGET IN THE 15-FOOT BUBBLE CHAMBER. Ermolov, P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii); Nezrick, F. A. (National Accelerator Lab., [Batavia], Ill.). 1970.

In 1970 summer study.

The utility of a track-sensitive target in neutrino experiments is discussed in view of the following aspects: photon-conversion efficiency, cost of chamber filling, neutrino flux through the target, background events outside the target, setting error when using a target, and optical distortions of a track-sensitive target. (auth)

12155 BUBBLE NUCLEATION IN CRYOGENIC FLUIDS. Bailey, C. A.; Bland, M. E.; Davey, G. (Oxford Univ.). pp 115-17 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Some results are reported of a study of bubble nucleation in saturated liquid nitrogen being carried out in a 120-mm bubble chamber using a high-speed ciné camera. The work is part of the research and development programme of the proposed Rutherford Laboratory High Field Bubble Chamber. (auth)

12156 VARIATION OF HEAT TRANSFER TO BOILING LIQUID HELIUM WITH PRESSURE. Firth, M.; Pilipenko, Yu. K. (CERN, Geneva). pp 147-50 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Heat transfer parameters have previously been measured and the effect of various cooling strip geometries determined for simulated sections of magnet winding for the 3.7-m European Bubble Chamber at CERN. The results obtained were restricted to temperatures similar to those at which it is intended to operate the magnet. As in some circumstances it may be advantageous to operate the magnet for short periods at different temperatures and hence equilibrium pressures, the previous investigations have been extended to measuring the significant heat transfer parameters over a range of pressures from the lambda point to the critical point using a simulated magnet winding section incorporating the cooling strip finally chosen for the magnet. It was found that the variation of the breakaway and recovery heat fluxes with equilibrium pressure for helium in the configuration investigated agrees qualitatively with the general behavior of other liquids. (auth)

12157 CURRENT LEADS FOR REFRIGERATOR-COOLED LARGE SUPERCONDUCTING MAGNETS. Guesewell, D.; Haebel, E.-U. (CERN, Geneva). pp 187-91 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The optimum design of current leads for Dewar-cooled magnets has been the subject of numerous investigations. Here, the special problems encountered with large refrigerator-cooled superconducting magnets are discussed, especially in relation to the Big European Bubble Chamber at CERN. (auth)

12158 CRYOGENIC ASPECTS OF THE 3.7-m EUROPEAN BUBBLE CHAMBER. Birchler, F.; Dauvergne, J. P.; Erdt, W.; (and others) (CERN, Geneva). pp 244-50 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

BEBC, the Big European Bubble Chamber, is a chamber of 3.7 m diameter presently under construction at CERN. The chamber will hold 33.5 m^3 of liquid hydrogen, liquid deuterium or liquid neon-hydrogen mixtures and work in the field of a 35 kG, 800 MJ superconducting magnet. Chamber and magnet will be cooled by a refrigerator of capacity equivalent to 25 kW at 22 K and 1.8 kW at 4.4 K. This paper deals with the chamber as a cryogenic apparatus and describes cryogenic problems relating to chamber cooling, magnet cooling and cryogenic safety. (auth)

12159 RECOVERY TIME OF NEON FLASH TUBES. Ashton, F.; Breare, J. M.; Holroyd, F. W.; Tsuji, K.; Wolfendale, A. W. (Univ. of Durham, Eng.). Lett. Nuovo Cim.; 2: No. 14, 707-11 (2 Oct 1971).

The characteristics of neon flash tube chambers for cosmic ray studies were examined. High repetition rates and long time delays between the particle and the application of the high-voltage pulse sometimes cause a loss of efficiency. This loss of efficiency is thought to be due to an internal remnant clearing field. It is attempted to explain the remnant clearing field and to estimate the magnitude of the remnant clearing field as a function of time. (W.H.K.)

12160 RESULTS OF INVESTIGATION OF A WIDE-GAP SPARK CHAMBER WITH COMPENSATION OF THE PARTICLE-TRACK DRIFT. Avakyan, K. M.; Aivazyan, R. B.; Krishchyan, V. M.; Matevosyan, E. M. JETP Lett. (USSR) (Engl. Transl.); 14: No. 6. 239-40(20 Sep 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 6. 356-9(20 Sep 1971).

The particle track drifts in a wide-gap spark chamber fed by high-voltage unipolar pulses and by high-voltage radio pulses were studied and compared. Graphical data are presented and discussed, and it is concluded that the spatial resolution of radio pulsed wide-gap spark chambers exceeds that of unipolar pulsed chambers. (W.H.K.)

12161 CORRELATION BETWEEN THE COUNTING RATES OF THE MESONTELESCOPE AND THE NEUTRON MONITOR. Kokkoniemi, J.; Kananen, H. (Oulu Univ., Finland). Geophysica; 11: 271-7(1971).

Registrations on the megamesontelescope and the neutron monitor have been compared in three different ways. The regression coefficient between them has been calculated, and the maximum amplitudes of enhanced (the first harmonic) daily variations have been compared as well as some simultaneous decreases of the pressure corrected intensities. It was observed that the overall regression coefficient was about 0.29. The averaged ratio of the maximum amplitudes in harmonic daily variations was 0.64. The amplitude ratio of the anharmonic decreases varied in the range 0.2 to 1.2 and was found to be approximately inversely proportional to the decrease. (auth) (Finland)

12162 MODULAR SPARK CHAMBER. Ghosh, Samir; Mundra, J. P.; Majumdar, D. (Presidency Coll., Calcutta). Indian J. Phys.; 44: No. 3, 188-93(Mar 1970).

The construction and operation of three different types of spark chambers are described. In particular, the operations of the modular spark chamber with argon and neon fillings at various pressures lower than one atmosphere are analyzed. (auth)

12163 ANALYZING SYSTEM FOR BUBBLE CHAMBER PHOTOGRAPHS. Fontaine, Gerard (to Agence Nationale de Valorisation de la Recherche). French Patent 2,061,517. 25 Jun 1971. Filed 14 Mar 1969. (In French).

An analyzing system, principally intended for the tracks on transparent bubble chamber photographs, is described. It consists of scanning the track with an analyzing spot, and involves the use of a photomultiplier receiving the light from the spot and producing a pulse signal when the spot is partially obscured by the track; a variable gain amplifier amplifies the photomultiplier signal. This amplifier includes a servo-loop in the form of an amplitude comparator: the amplifier output signal is compared with a reference voltage. The system also incorporates a means of applying the error-signal from the output of the comparator to a storage capacitor and an amplifier gain control, and a switch in the servo-loop. Discrimination of the leading edge of the output amplifier signal, and a means of controlling the switch during a predetermined time, when the slope exceeds a predetermined value, are envisaged. (France)

Radiation Dosimeters

Refer also to abstracts 11772, 12293, 12298, 12301, 12311, 12318, 12324, and 13389.

12164 SIMPLIFIED METHOD OF FINDING QUANTUM RADIATION ENERGY AND ITS INCIDENT DIRECTION USING A SINGLE DOSIMETER GLASS. Yokota, R.; Muto, Y. (Toshiba Research and Development Center, Kawasaki, Japan). Health Phys.; 21: No. 4, 597-8(Oct 1971).

A special cell using FD-P8-3 glass is described which was developed to insert into the FGD-6 fluorimeter, so that the energy and incident direction of exposure could be determined. (UK)

12165 EXPOSURE METERS FOR PROTECTION AGAINST X-RAYS BETWEEN 10 AND 100 kV: METHOD OF CALIBRATION AND CHARACTERISTICS OF VARIOUS TYPES OF INSTRUMENTS. Oosterkamp, W. J.; de Wijk, J. J. F. (Philips Gloeilampen-

fabrieken NV, Eindhoven, Netherlands). pp 27-30 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Soft x-radiation can be measured with ionization chambers or Geiger–Mueller counter tubes. These instruments have to be calibrated at such low x-ray intensities that the standard exposure meter which has an effective ionization volume of 0.08 cm^3 cannot be used. An intermediate chamber having a volume 2000 times that of the standard chamber is used. With a suitably chosen exposure rate, it is possible to calibrate the intermediate chamber with respect to the standard chamber, and then using a higher resistance, to check the instruments to be calibrated against the intermediate chamber. (France)

12166 USE OF THERMOLUMINESCENT GLASS DOSIMETERS IN THE MEASUREMENT OF SOFT ELECTROMAGNETIC RADIATION. Bochvar, I. A.; Keyrim-Markus, I. B.; Kushnerev, A. Y. (Inst. of Biophysics, Moscow). pp 31-4 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Thermoluminescent dosimeters based on aluminophosphate glasses were studied, and their characteristics are given. Glasses of various compositions with effective atomic numbers lying between 11.7 and 18.6 possess characteristics suitable for dose measurements in bone tissues. Large volume dosimeters were exposed to x-rays and the energy dependence curves are plotted. (France)

12167 INTERPRETATION OF THE ANGULAR DEPENDENCE OF THE PHOTOGRAPHIC RESPONSE TO GAMMA RAYS OF BARE MONITORING FILMS IN COMBINATION WITH METALLIC FILTERS. Paic, V.; Paic, M. (Univ., Zagreb). pp 69-73 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Films were exposed to 800 mR from a ^{60}Co γ-ray source at various angles of incidence. Such a source can be considered as a point source. The net photographic densities corresponding to the unfiltered and filtered parts of the film were measured; the dependence of the blackening of the films on the atomic number of the filters can be interpreted using Hine's measurements of the secondary radiation, made with an ionization chamber. The backscattering of the secondary radiation on the filter must be taken into account when the filter is in the backward position. (France)

12168 X-RAY DOSIMETRY USING RADIOLUMINESCENT GLASSES. Chapuis, A. M. (CEN, Fontenay-aux-Roses, France); Francois, H.; Nicodeme, M.; Carpentier, S. pp 96-101 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Problems arising in the dosimetry of x-ray generating equipment are dealt with. The response of a dosimeter assembly, consisting of four glasses protected by different filters irradiated with low energy x-radiation (8 to 220 keV), was studied. It is shown that it is possible to determine the exposure by a linear combination of the detector responses. The errors are discussed. (France)

12169 COMPARISON BETWEEN THE RESULTS OBTAINED FROM DOSE MEASUREMENTS BY THERMOLUMINESCENCE AND PHOTOGRAPHIC FILM DOSIMETRY IN THE ENERGY RANGE 20 TO 200 keV. Ruault, P. A.; Gatineau, J. P. (Gaz de France, Saint-Denis). pp 231-9 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

In order to account for the large differences obtained between measurements made of a given 500 mR dose using thermoluminescence and photographic techniques, curves representing the variations in the optical density of GEVAERT D7 and KODAK DEFINIX emulsions irradiated with various energy monochromatic radiations were traced. Monochromatic beams were obtained by filtering the x-rays. The variation in filter thickness is presented as a function of the energy of the filtered radiation for each accelerating potential applied to the x-ray generator. Exposure times corresponding to a 500 mR dose and the spectral sensitivity and blackening curves of the emulsions were determined. (auth)

12170 DOSE-RATE DEPENDENCE OF LITHIUM FLUORIDE FOR EXPOSURES ABOVE 15,000 R PER PULSE. Goldstein, N. (Physics International Co., San Leandro, Calif.). Health Phys.; 22: No. 1, 90-1(Jan 1972).

Flash x-rays from Pulserad machines were used to compare the response of lithium fluoride with other detectors. For the highest exposure registered, $Li_2B_4O_7$: Mn, CaF_2 : Mn, and BeO measured 50,000 R compared with 35,000 R for LiF. Exposure values were based on equivalent response to a ^{137}Cs γ ray source. Data are also presented of other comparisons made with $Li_2B_4O_7$: Mn and silicon calorimetry. Exposures of $Li_2B_4O_7$: Mn and carbon calorimeters to pulsed electron beams indicated the possibility of a dose-rate dependency for $Li_2B_4O_7$ beginning between 100,000 and 150,000 R. (UK)

12171 IONIZATION CHAMBER FOR THE MEASUREMENT OF THERMALLY STIMULATED EXOELECTRONS. Lariviere, P. D. (Radiation Detection Co., Mount View, Calif.); Tochilin, E. Health Phys.; 22: No. 2, 198-201(Feb 1972).

An ionization chamber system for TSEE dosimeter readout is described, which was used over an exposure range of 10 to 10^6 R in an investigation of thermoluminescent and exoelectron emitters of atomic number higher than tissue equivalent. Thermally stimulated exoelectron emission curves for LiF and BeO are presented, and thermally stimulated dose response curves for BeO, LiF and MgF_2, following irradiation with ^{137}Cs at 10^4 R/hr are also shown. (UK)

12172 THERMOLUMINESCENCE FROM ADHESIVE COATED TEFLON TAPE. Shipler, D. B. (Oregon Tech. Inst., Klamath Falls); Nicholls, L. L.; Kocher, L. F. Health Phys.; 22: No. 2, 195-6(Feb 1972).

A study was made of heat deflection, thermoluminescence, and ultraviolet sensitivity shown by various adhesive coated Teflon tapes used for mounting LiF in dosimeter badges. Adhesive thermoluminescence was not a problem at read-out temperatures up to 250° but was significant in neutron dosimetry where the appropriate read-out temperature was 300°C. The fluorescent spectrum from one Teflon tape adhesive was a broad band emission from 300 to 650 nm with the maximum at about 500 nm, and overlapped that of LiF with a maximum of 400 nm. A badge was made of a block of LiF sandwiched between one piece of adhesive coated TFE Teflon tape and one piece of plain tape. Heating was carried out on the plain side at 300°C for 20 sec, and the temperature differential of 30°C was sufficient to preclude the adhesive thermoluminescence. Studies were made between 180 and 380°C of the response of two pieces of adhesive coated tape and a sandwich badge of LiF before and after exposure to ultraviolet light. The use of narrow band interference filters between the thermoluminescent dosimeter and the photomultiplier tube is also mentioned. (UK)

12173 PERFORMANCE SPECIFICATIONS FOR DIRECT READING AND INDIRECT READING POCKET DOSIMETERS FOR X- AND GAMMA RADIATION. ANSI N13.5 1970. New York; American National Standards Institute (1970). 10p.

Performance characteristics of direct and indirect reading pocket ionization dosimeters are defined. These recommendations apply to pocket dosimeters for dosimetry of x or gamma radiation with energies from 30 keV to 3 MeV. (W.H.K.)

Radiometric Instruments

Refer also to abstracts 12046–12048, 12052, 12053, and 13412.

12174 (BHO–67–4) EVALUATION OF ISOTOPIC SOURCE ASSAY SYSTEM (ISAS) UNDER COMMERCIAL OPERATING CONDITIONS. Final Technical Report, March 25, 1970–March 25, 1971. Gallagher, W. J. (United Nuclear Corp., New Haven, Conn. Commercial Products Div.). Contract AT(30-1)-67. 73p. Dep. NTIS.

Isotopic neutron source assay systems (ISAS) were installed at two commercial facilities to determine the worth of the instruments for special nuclear materials control and safeguards under

commercial operating conditions. The ISAS units were designed, fabricated, and installed by Gulf Radiation Technology (now Gulf Energy & Environmental Systems) under subcontract to United Nuclear Corporation. The ISAS units were used to measure a variety of compounds, mixtures, and alloys, as well as uranyl nitrate solution containing uranium of ^{235}U enrichments ranging from 2 to 97%. These materials were packaged within 5-in. diameter × 6¾-in. steel cans, or 5¾-in. diameter × 11-in. poly jugs of 1-gal volume. Up to 5 kg of ^{235}U per container was assayed without reaching the limit of ISAS. Determination of accuracy based upon three sets of comparisons between ISAS assays and chemical and mass spectrographic analytical data, obtained during reprocessing of the material, has indicated that ±2% accuracy can be obtained on dry homogeneous materials containing large quantities of uranium-235 when identical standards are used. The precision (reproducibility) of the assay system is, as is expected, controlled by counting statistics. The sensitivity of the two ISAS units for unmoderated samples differs significantly, apparently due to the softer neutron spectrum in ISAS No. 1. ISAS No. 1 gives approximately twice the net signal for 300 grams of unmoderated ^{235}U as ISAS No. 2. ISAS No. 2 can detect 5 grams of ^{235}U distributed in 5 kg of Al_2O_3 in a one-gallon polyethylene jug. The lower limits of detection for ISAS No. 1, or for moderated fissile material in either unit, were not determined. The units proved to be relatively trouble-free, the major operational failures occurring in the mechanical drive units for the sample carriers. The sample carriers of these two prototype ISAS units should be replaced with top-mounted, heavier sample carriers. The cost of operation of the systems is relatively low and within the ranges which have been experienced for gamma counting. The ISAS provides a means of quickly assaying the ^{235}U content of materials, such as bulk residues and slags, to a degree of accuracy which has until now been unattainable. There are many unanswered questions concerning ISAS (such as how well it can measure the fertile material content of enriched uranium bearing materials), but the system, as it presently exists, is an assay tool which will be valuable to special nuclear materials control and safeguards. Its utility could be substantially enhanced by improvement of the accuracy of measurement with small quantities of ^{235}U. (auth)

12175 INVERSE PROBES FOR THE SELECTIVE GAMMA–GAMMA METHOD. Artsybashev, V. A. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 128-34(1969). (In Russian).

A theoretical and methodical attempt to develop an interference-proof, selective probe suitable for use with the gamma radiation sources ^{75}Se, ^{137}Cs, and ^{60}Co is presented. Formulas and constants are recommended for a preliminary choice of parameters for a doubly inverse probe. Final compensation of the double probe is completed experimentally. For the optimum design of the double probe the stability requirement is evaluated for the basic elements of the probe, and attention is given to the preciseness of the lead collimator. (tr-auth)

12176 SOME PECULIARITIES OF SECONDARY GAMMA SPECTRA IN THE GEOMETRY OF DIRECT VISIBILITY AND THEIR USE IN THE X-RAY RADIOMETRIC METHOD. Mitov, V. N.; Yanshevskii, Yu. P.; Leman, E. P. Zap. Leningrad. Gorn. Inst.; 56: No. 2, 122-7(1969). (In Russian).

The position of a line of a single scattering of radiation depends on the angle between the collimator and the energy source. Equilibrium points of the spectrum exist in which absorption and excitation processes mutually compensate. These special features of gamma spectra may be used in an x-ray radiometric method for increasing the sensitivity and decreasing the effect of a series of interfering factors (changes in the material composition and ore structure). (tr-auth)

12177 METHOD OF USING A β RAY BACKSCATTERING FOR MEASURING THICKNESSES. Roche, Guy; Riss, Claude (to Cegedur, G. P.). French Patent 2,062,071. 1 Jun 1971. Filed 9 Oct 1969. (In French).

A method involving the use of β ray backscattering to determine the thickness of different coatings is described. The method is particularly suitable for the case of organic coatings on thin light metal foils, the β rays being emitted by one or several sources, and one or several detectors being used to measure the intensity of the backscattered β radiation. The method is characterized by the fact that the part to be examined and the β ray source(s) and detector(s) are placed in the same enclosure containing a gas, which is lighter than air. (France)

Miscellaneous Instruments and Components

Refer also to abstracts 11495 and 13876.

12178 PULSE-AMPLITUDE ANALYSER HAS VARIABLE DEAD TIME. Bialkowski, J. (Inst. of Nuclear Research, Swierk, Poland). Electron. Eng.; 43: No. 526, 28-31(Dec 1971).

A d.c.-coupled single-channel pulse-amplitude analyzer with a baseline range of 0.1 to 10 V, channel width of 0.05 to 5 V and a variable dead time is described. Results obtained with the instrument give an integral linearity better than 0.1% and drift due to temperature less than 0.5 mV/°C up to 60°C. The maximum threshold shift due to the intensity change up to 0.5×10^6 pulse/s is less than ±0.1%. (auth)

12179 CdTe HOLE LIFETIME FROM THE GAMMA-RAY AND PHOTO-INDUCED EFFECTS. Desnica, U. V.; Urli, N. B. (Inst. Ruder Boskovic, Zagreb). Fizika (Zagreb); 3: No. 4, 259-68(Oct 1971).

Two independent methods, the gamma-ray-induced photovoltaic effect and the monochromatic light-induced photoeffect, were used for determination of the minority-carrier lifetime in indium-doped n-type CdTe. The existing expressions for collection efficiency of electron–hole pairs generated by visible light near the p–n junction were extended to include a contribution of the depletion layer. P–n junctions formed by electrodeless plating of gold had a relatively high capacitance associated with a very narrow depletion region. The short-circuit current of the diodes was measured during irradiation in the ^{60}Co gamma source. The values of lifetime of holes in CdTe (of the order of 5×10^{-10} sec), obtained by the two methods, were in agreement within the limits of experimental errors. (auth)

12180 X-RAY INTERLOCK SYSTEM FOR THE PHILIPS VERTICAL DIFFRACTION UNIT. Howard, R. M.; Lewis, J. E. (Jones and Laughlin Steel Corp., Pittsburgh). Health Phys.; 22: No. 1, 94-6(Jan 1972).

An illustrated account is given of an electro-mechanical interlocking system designed to eliminate personal exposure from the Philips vertical diffractometer. Circuit diagrams are given. Sample changes could be made at goniometer and pole figure device units without interrupting the high voltage. (UK)

12181 BREEDER FUEL ROD CAN TESTING: A NOVEL MEASUREMENT AND CONTROL SYSTEM. Schmidt, L. (Nuclear Research Centre, Karlsruhe, Ger.). Nucl. Eng. Int.; 17: No. 188, 41-3(Jan 1972).

A measurement and control system is described for testing fuel cans under alternating thermal and mechanical loads. The system, now being used for out-of-pile experiments, forms part of an irradiation installation for in-pile experiments in BR2. Details are given of methods of temperature and pressure control, and leak detection. (UK)

12182 VARIABLE TEMPERATURE CELL HOUSING FOR PULSE RADIOLYSIS FLOW SYSTEMS. Wardman, P. (Univ. of Manchester, Eng.). J. Phys., E (London); 5: No. 1, 17-18 (Jan 1972).

A cell housing is described which allows the convenient variation in temperature between −160 and +150°C of liquid samples in a spectroscopic cell which may be made part of a flow system to permit sample changing. (auth)

12183 NUCLEAR ELECTRONICS: PARALLEL OUTPUT COMMUTATOR FOR CONNECTING A PARALLEL PRINTER TO SEVERAL MULTI-CHANNEL ANALYSERS. Nessel, R. (Technische Hochschule, Darmstadt, Ger.). Kerntech. Atomprax.; 13: No. 9, 403-5(Sep 1971). (In German and English).

The data output of multi-channel analyzers is often printed out by parallel printers. Often there is only one printer for several analyzers. The parallel-output commutator described will allow the read-out of four analyzers with one parallel printer without any connecting work and no interference between the analyzers (auth)

12184 IMPROVEMENTS IN OR RELATING TO LENGTH GAUGING APPARATUS. Clare, Ernest (to United Kingdom Atomic Energy Authority). British Patent 1,257,020. 15 Dec 1971. Filed 4 Mar 1968.

Apparatus is described for determining if the overall lengths of columns of repetitively produced bodies lie within predetermined tolerance limits; application to pelleted reactor fuel elements is claimed. The apparatus comprises means for supporting the bodies in a number of stacks so that each stack is engaged at one end by a stop and at the other end by a length measuring device. Means are provided for integrating the readings of all the length measuring devices so as to give the total length of the several stacks. The length measuring devices may comprise resiliently loaded plungers operating in cylinders containing a liquid which is

displaced in accordance with the stack length, to provide a length indication. (UK)

12185 SPECTROMETRY OF X-RAYS EMITTED BY APPARATUSES WITH ACCELERATING VOLTAGE BETWEEN 60 TO 280 kV. Casnati, E.; Paganini Fioratti, M.; Piermattei, S. (CNEN, Casaccia, Italy). pp 89-95 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France: Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Results concerning the spectral distributions of x-rays emitted by two commercial tubes are presented: a Be-window (0.025 cm Be) self-rectifying tube with peak voltage variable in the range 5 to 80 kV and a 100 to 300 kV constant potential apparatus (Trimegagil) with inherent filtration equal to 0.05 cm Cu. The methods used are scintillation spectrometry and absorption analysis. The scintillation spectrometer using a NaI crystal as the detector is the most direct method of obtaining the spectral distribution. In order to avoid saturation phenomena of the detector and the electronic circuits, the beam intensity must not be too high. The method also requires a rather expensive instrumentation and laborious analysis of the data. Absorption analysis is particularly suitable for routine measurements; it requires a simple and economic experimental set-up and can be easily applied to low or high intensity beams. A limit, however, occurs as to the maximum energy of the radiation to be studied and moreover the incident spectrum must be continuous. (France)

12186 LIMITING CAPABILITIES OF A QUADRUPOLE MASS SPECTROMETER. Slobodenyuk, G. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 798-802(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 1016-22(May 1971).

Certain physical factors that limit the basic capabilities of the quadrupole mass spectrometer are examined. Numerical estimates are given for limits on the resolution, the rate at which mass spectra can be recorded, the sensitivity, the mass range, the maximum working pressure, and the dynamic range. (auth)

12187 MINIATURIZED GAMMA-INCLINOMETER FOR DETERMINING THE ATTITUDE OF RADIOACTIVE LAYERS. Kirpishchikov, S. P.; Mikhaylov, V. G.; Radolitskii, A. I. Geofiz. App.; No. 41, 104-9(1969). (In Russian).

In the case of a section with poor electrical contrasts, and also in coreless drilling, it is recommended that for wells 59 to 120 mm or more in diameter a gamma-inclinometer be used to determine the attitude of radioactive layers. The gamma inclinometer consists of a self-orienting system with three scintillation counters set 45 cm apart, and a shelf in which the electrical scheme is mounted. The instrument is enclosed in a metal casing 51 mm in diameter. It works in any logging station in which the panel of any scintillation radiometer can be installed. The procedure of operation and attitude determination is similar to that using type NP-1 formation inclinometers. (Geophys. Abstr.)

12188 CORRECTIVE ACTION PROGRAM FOR A MAL-FUNCTIONING COMMERCIAL X-RAY DIFFRACTION SHUTTER SYSTEM. Moore, T. M.; Britain, R. G. (Dept. of Health, Education and Welfare, Rockville, Md.). Health Phys.; 22: No. 1, 107-8(Jan 1972).

Notes are added to a previous report [Health Phys.; 21: No. 6, 639(June 1971)] of the failure of an x ray diffraction unit shutter system, manufactured by Philips Electronic Instruments (Norelco). Subsequent surveys, replacements and modifications of the design and manufacturing and testing procedures are listed. (UK)

12189 DEVICE FOR DETERMINING THE PULSES OF FLOWS OF CHARGED AND NEUTRAL PARTICLES. Kubarev, Yu. V. Tr. Mosk. Inst. Radiotekh., Elektron.; No. 43, 86-91 (1969). (In Russian).

Two instruments are described which are capable of measuring the effect of current on a body. The first of these measures current pulses of charged particles, and is basically an electron-parametric counter consisting of a vacuum-tube converter-mechanotron which measures the characteristics of electron flow during interaction-drift of these electrons. A typical calibration curve is depicted and explained. The measurement of small current pulses of charged and neutral particles is possible with a draft gage constructed from a 50-μA microammeter with certain modifications. For eliminating the effects of external electric and magnetic fields, the equipment is inserted into a case of ferromagnetic material. A calibration curve is illustrated together with a schematic diagram of the circuit. (K.S.W.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 13907.

12190 (N-71-18050) SPECTROGRAPHIC STUDIES OF LUMINESCENCE IN CHARGED-PARTICLE-IRRADIATED OPTICAL MATERIALS. Romanko, John; McDaniel, R. H.; Miles, J. K.; Cheever, P. R.; Massingill, G. S. (General Dynamics/Fort Worth, Tex.). 21 Mar 1969. Contract NAS1-7734. 152p. (NASA-CR-66758; FZK-364). NTIS.

An experimental investigation was conducted to determine the luminescence induced in optical glasses and quartzes by high-energy charged particles. Spectral luminescence was measured in the wavelength range from 300 to 650 nanometers at a resolution of 0.5 nm utilizing a grating spectrograph. Electron irradiations were performed at six energies from 1 to 20 MeV and proton irradiations at 1, 2, and 3 MeV. Induced luminescence from the specimens varied from a few tenths to approximately 100 nanowatts/sq cm-steradian-nonometer in the visible region. The luminescence of quartzes was found to be linear with flux and absorbed dose of 1, 2, and 3 MeV electrons. Luminescence induced by comparable proton irradiation was nonlinear with flux and absorbed dose, probably due to heating effects. Line spectra characteristics of excited silicon, sodium, and calcium were observed in electron-irradiated Solex. Molecular bands of N2 and N2(+) were observed in experiments performed in air. Transmission measurements were made on a number of pulsed-electron-irradiated glasses in the visible and infrared wavelength regions. (auth)

12191 EFFECT OF NEUTRONS AND X RADIATION ON RESONANCE FREQUENCY AND ELASTIC PROPERTIES OF PIEZOELECTRIC QUARTZ VIBRATORS. Krebs, Milan (Vysoka Skola Strojni a Textilni, Liberec, Czech.). Cesk. Cas. Fys.; 21: No. 3, 595-602(1971). (In Czech).

An analysis of experimental results on the effect of neutrons is given, and measurements of the effect of x radiation on the resonance frequency and the elastic properties of piezoelectric quartz vibrators are described. According to the measurements, there occurs a drop in resonance frequency when piezoelectric vibrators are exposed to x radiation. The measured drop in frequency, which displays saturation, was noted to take place even for those kinds of vibrators which exhibited an increase in neutron irradiation. In a discussion of the results, several microstructural models are proposed to explain the measured phenomena. (auth)

12192 RADIOLUMINESCENCE AND CHERENKOV RADIATION OF PHOTOELECTRON MULTIPLIERS IN A GAMMA FIELD. Lyutsko, A. M.; Nguyen Kuang Min; Pertsev, A. N.; Pokryshkin, A. I.; Satsunkevich, M. B. Zh. Prikl. Spektrosk.; 15: No. 1, 59-61(Jul 1971). (In Russian).

The effect of ^{60}Co gamma radiation on the scattering amplitude and number of noise pulses was investigated at dose levels ranging from zero to 40 μR/sec in five types of photoelectron multipliers. The results are explained by the phenomena of radioluminescence and Cherenkov radiation of the glass envelopes in the circuitry. A plateau in the function of the noise impulses was noted; the slope depended on the magnitude of the dose, the quantity of glass present, and the intensity of the Cherenkov radiation. (tr-auth)

12193 DECALIBRATION OF LOW-TEMPERATURE THERMOCOUPLES BY REACTOR IRRADIATION: PRELIMINARY RESULTS. Koeppe, W. (Kernforschungsanlage, Juelich, Ger.). pp 220-5 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Preliminary results are given of measurements on the decalibration of chromel–alumel, iron–constantan, and copper–gold + cobalt (2.1 at. %) thermocouples by reactor irradiation at low temperatures. The cold neutron source in the FRJ-2 reactor was used as a low-temperature irradiation facility for this purpose. Calculations on the nuclear alloying rate of the gold + cobalt thermocouple wire are supplied for comparison. For an irradiation time of about one year at a thermal flux near 10^{14} n/cm^2 · sec the effect of low-temperature irradiation on the chromel–alumel and iron–constantan thermocouples is not very large, while the copper–gold + cobalt thermocouple is very strongly affected under these conditions, probably due to the remarkable nuclear alloying with mercury. Thus the latter thermocouple seems not well suited for the measurement of temperatures during lengthy low-temperature reactor experiments. (auth)

12194 FAST NEUTRON RADIATION STABILITY OF SILICON DETECTORS. Lazutkin, I. I.; Sinitsyn, B. I.; Fedoseeva, O. P.; Tsypin, S. G. At. Energ. (USSR); 31: No. 6, 636-7(Dec 1971). (In Russian).

Changes in silicon surface-barrier detectors were studied as a function of fast neutron flux. Properties such as reverse current, internal noise, power resolution, volume resistance, and effectiveness of charge collection were measured over the reverse voltage range of 0 to 15 V. Neutron fluxes under investigation ranged from 2.2×10^8 to 5.5×10^8 n/cm^2 · sec. (K.S.W.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 13348.

Basic Processes

Refer also to abstracts 11951, 12368, 12378, and 12494.

12195 (BNWL–1550(Pt.1), pp 23-34) CELLULAR REGULATORY MECHANISMS. (Battelle Pacific Northwest Labs., Richland, Wash.).

The basic cellular and molecular level studies included in this project are directed toward the elucidation of the mechanisms involved in regulation of enzyme synthesis and growth in eucaryotic organisms. The ultimate goal is to apply this information to an investigation of the primary effects of ionizing radiation. Present studies are concentrated on the cellular control mechanisms in a fairly simple, but representative, eucaryotic cell, Neurospora crassa. Progress has been made in understanding the role of the gene in the transcriptional and posttranscriptional control of enzyme synthesis. Work is described that shows how the absence or presence of a simple alkaline earth metal ion can alter the activity and/or specificity of an enzyme, and how the molecular composition of the cell membrane, one of the crucial organelles of the cell, affects its properties and metabolism. (auth)

12196 (BNWL–1550(Pt.1), pp 107-8) DEVELOPMENT AND EVALUATION OF BLOOD IRRADIATORS. Hungate, F. P.; Cross, F. T.; Karagianes, M. T.; Gillis, M. F. (Battelle Pacific Northwest Labs., Richland, Wash.).

The photon emitters, ^{55}Fe and ^{125}I, were used as source materials in devices that were implanted in the thoracic aorta of dogs for chronic irradiation of blood. Blood samples taken from dogs following implantation were submitted to routine hematology and examined for the presence of any source isotope in the blood. It was found that irradiators capable of significantly irradiating blood, but which emit no appreciable radiation to surrounding tissues, can be made small enough for easy implantation. Thallium-204 is now being used in the development of irradiators. (H.L.W.)

12197 (CONF-710402–(Vol.1), pp 9-15) ATOMIC ENERGY COMMISSION'S GROWING INVOLVEMENT IN MOLECULAR BIOLOGY. Larson, Clarence E. (Atomic Energy Commission, Washington, D. C.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Recent applications of molecular biology in research are reviewed. It is pointed out that many goals of nuclear research and molecular biology overlap since both seek to understand the basic units of matter and life. Predictions of future applications of molecular biology are presented. (C.H.)

12198 (CONF-710402–(Vol.1), pp II.19-25) USES OF ACTIVATION ANALYSIS IN BIOMEDICAL PROBLEMS. Maletskos, Constantine J. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The general uses of activation analysis in biomedical problems are reviewed. The five main applications of the method include: elemental analysis; the use of enriched stable isotopic tracers; autoradiography; clinical tests; and in vivo measurements (nondestructive chemical analysis of living systems). Advantages and disadvantages of the different applications are described in addition to the main requirements. It is particularly stressed that it now be considered as a tool and that it must compete as such with other tools in the arsenal available to a person who is interested in solving biomedical problems. It is concluded that the method has good potential, but that it is still in the slow part of its growth curve, that the economics of the method is one of its greater drawbacks, and that the next few years will show how this potential will develop. (auth)

12199 (CONF-710402–(Vol.1), pp V.14-19) HIGH RESOLUTION NEUTRON-INDUCED AUTORADIOGRAPHY OF BONE. Jee, Webster S. S.; Dell, Rebecca (Utah Univ., Salt Lake City. Coll. of Medicine); Miller, Lowell G. (Idaho Nuclear Corp., Idaho Falls). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The detailed neutron-induced autoradiographic process for bones containing plutonium-239 produced autoradiographs with both fission fragment tracks and a corresponding bone image. Seven microns thick undecalcified bone sections were apposed on 300 microns thick Lexan (polycarbonate) film and exposed to neutrons in the thermal column of the Material Testing Reactor (MTR) at the National Reactor Testing Station in Idaho. The specimens were immersed in 28% KOH at 60°C for one hour to etch pinholes at the location of each fission track and pitting of the film at the location of the bone. The film, when inspected microscopically, exhibited both fission fragment tracks and a corresponding bone image. When the films were etched immediately after irradiation, no bone image was produced. When the bone sections were allowed to remain on the film for several weeks after irradiation, the bone caused a pitting of the film surface. Betas from phosphorus-32 seemed to be the only charged particles available to produce the pitting. This detailed neutron-induced autoradiographic process has advantages over the nuclear emulsion autoradiography of bones because it eliminated long exposure times and fading of latent image. (auth)

12200 STUDY OF AFFINITY OF A MALIGNANT TUMOR AND ORGANS FOR THE ELEMENTS IN GROUP II OF THE PERIODIC TABLE. Ando, Atsushi (Kanazawa Univ., Japan); Hisada, Kin-ichi. Radioisotopes (Tokyo); 20: No. 6, 273-8(Jun 1971). (In Japanese).

Seven preparations, ^{115m}Cd-chloride, ^{115m}Cd-citrate, ^{115m}Cd-EDTA, ^{65}Zn-chloride, ^{85}Sr-chloride, ^{85}Sr-citrate, and ^{85}Sr-EDTA were injected intravenously to each group of rats transplanted subcutaneously with Yoshida sarcoma. These rats were sacrificed at various periods after injection of each preparation: 3, 24, and 48 hrs in ^{115m}Cd-chloride and ^{115m}Cd-citrate, 3 and 24 hrs in ^{115m}Cd-EDTA and ^{65}Zn-chloride, 15 min, 3 hrs, and 24 hrs in ^{85}Sr-citrate, and 15 min and 24 hrs in ^{85}Sr-chloride and ^{85}Sr-EDTA. The radioactivities of tumor, blood, muscle, liver, kidney, pancreas, and spleen were measured by a well-type scintillation counter, and retention values in every tissue including tumor were calculated (in percent of administered dose per g-tissue weight). Cadmium-115m-chloride, ^{115m}Cd-citrate, and ^{65}Zn-chloride had very strong affinity for the liver and considerably strong affinity for the pancreas and kidney. Cadmium-115m-EDTA had considerably strong affinity for the kidney and liver, but had no affinity for the pancreas. Cadmium-115m- and ^{65}Zn-compounds had little affinity for the malignant tumor. Strontium-85 compounds were rapidly cleared from these organs, but clearance of ^{85}Sr-compounds in the tumor was slower than in the other organs. Cadmium, Zn, and Sr (the elements in group II of the periodic table) had little affinity for the malignant tumor. (auth)

12201 ACCELERATED PARTICLES IN BIOLOGICAL RESEARCH. Tobias, C. A. (Univ. of California, Berkeley); Maccabee, H. D. pp 195-240 of Elementary Particles. Science, Technology, and Society. /Yuan, Luke C. L. (ed.). New York; Academic Press Inc. (1971).

Biological studies during the past 25 years using accelerated particles are reviewed. The present status of the use of heavy particles in cancer therapy is reviewed. It is postulated that heavy ion microscopes will be developed for cytological studies and laminar heavy-ion roentgenographic techniques will be used for clinical measurements of body section density. (51 references) (C.H.)

12202 TREATMENT OF THE MICE IRRADIATED LETHALLY WITH ^{60}Co γ-RAY BY USING THE BONE MARROW TRANSPLANTATION. I. THE FATE OF THE LABELED BONE CELLS WHICH WERE TRANSPLANTED INTO THE ^{60}Co γ-RAY LETHALLY IRRADIATED MOUSE. Niimi, Masanobu (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 218-37(1971). (In Japanese).

There are many unsolved problems in the clinical use of bone marrow transplantation for treatment of lethally irradiated patients. Of these problems, the most difficult one is how to suppress allograft rejections occurring with the treatment. On the other hand, after various studies on the mechanism of bone marrow transplantation, it is generally accepted that the transplanted bone marrow cells are able to divide and proliferate in the hematopoietic organs of the lethally irradiated host, however there seems to be many questions concerning how the detailed mechanism functions in relation to the fate of the transplanted bone marrow cells. Recently, research using bone marrow cells labeled with radioactive isotopes were reported, but they only reported the distribution of the transplanted bone marrow cells in the host shortly after transplantation. Using autoradiography, the fate of

the syngeneic bone marrow cells labeled with tritiated thymidine, which was transplanted into the ^{60}Co γ-ray lethally irradiated mouse was studied, and the following conclusions were drawn. The finding that grain counts per labeled cell diminished gradually as time passed suggests that the labeled cells at various stages of maturity were mitotically active and were able to proliferate in the hematopoietic organs of the recipient soon after transplantation. The findings that the ratio of the nucleated labeled cells consisting of various kinds of labeled bone marrow cells except for banded and segmented neutrophils increased as time passed suggests that one part of this proliferation was derived from stem cells. The finding that the labeled cells were observed in various organs of the recipient shortly after transplantation, but that thereafter they were observed only in the bone marrow and the spleen suggests some kinds of selectively for the hematopoietic cells. (auth)

12203 ESTIMATION OF PARTICLE SIZE DISTRIBUTION PARAMETERS IN ANIMAL LUNGS. Thomas, R. G. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. J. Aerosol Sci.; 2: No. 4, 393-400(Dec 1971).

A constant of specific solubility of 2.5×10^{-8} g cm^{-2} day^{-1} was determined for fused aluminosilicate particles, by observing in vivo retention kinetics after intravenous injection into rats. Studies over the past years, in which dogs and rats inhaled labeled aerosols of these particles, showed retention half-lives in the lung of 460 and 285 days, respectively. By applying these values for solubility and half-life to Mercer's theory of dissolution from the deep lung, the initial distribution of particles deposited in the pulmonary regions of dogs and rats following inhalation was calculated. From an inhaled aerosol with a mass median diameter, D_m, of 1.0 μm and $\sigma_g = 1.7$, a distribution described by $D_m = 0.51$ μm and σ_g's ranging from 1.16 to 1.48 was estimated to have been deposited in the Beagle dog lung, and a $D_m = 0.32$ μm and σ_g's ranging from 1.18 to 1.29 was similarly calculated for rats. (UK)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 12104, 12256, 12281, 12301, 12309, 12362–12364, 12438, 12442–12445, 12447, 12507, and 12509.

12204 (BNWL-1550(Pt.1), pp 65-81) INHALATION STUDIES. (Battelle Pacific Northwest Labs., Richland, Wash.).

Progress is reported on the following research projects: computer simulation of the retention and translocation of inhaled $^{239}PuO_2$ in beagle dogs; metabolism of inhaled ^{239}Pu citrate and ^{239}Pu nitrate; in vitro study of canine lung tumors; carcinogenesis from intraperitoneally deposited PuO_2 particles; distribution of inhaled metal oxides in pulmonary alveoli; removal of plutonium and macrophages by lung washings; metabolism of ^{145}Sm and ^{147}Pm in rats; and choline incorporation into lecithin. (H.L.W.)

12205 (BNWL-1550(Pt.1), pp 83) LOW LEVEL PLUTONIUM INHALATION STUDIES IN BEAGLES. (Battelle Pacific Northwest Labs., Richland, Wash.).

This project is concerned with a specific experiment to determine the long-term effects in beagle dogs of low-level inhalation exposure to plutonium dioxide. The experiment will extend previous and continuing studies in our laboratory on the effects of higher level exposures. The initiation of the project is proceeding as outlined in last year's report, with no results to justify a report this year. (auth)

12206 (CONF-710402-(Vol.1), pp V.20-6) STABLE ^{50}Cr AND NEUTRON ACTIVATION ANALYSIS IN THE STUDY OF THE KINETICS OF RED CELLS. Glomski, Chester A.; Pillay, K. K. S.; Thomas, Charles C. Jr. (State Univ. of New York, Buffalo). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The labeling of erythrocytes with stable isotope ^{50}Cr followed by instrumental activation analysis is a satisfactory method of monitoring the survival of erythrocytes. The method discussed is highly sensitive and reproducible, and allows critical quantitation without resorting to chemical separation of the label from the blood. The mean ^{50}Cr half-life of autologous erythrocytes in the rhesus monkey determined by this approach is 17.8 days (s.d. ± 1.1) as compared with 17.1 days (s.d. ± 0.8) derived by standard ^{51}Cr tagging and gamma-ray spectrometry. In addition the tag can be identified and accurately quantitated in the tissues of erythrocyte sequestration and destruction by this same activation analytical procedure. Tissues and body fluids from rabbits injected with ^{50}Cr-labeled erythrocytes were analyzed for the content of the metal-label. The materials studied included blood, urine, bile, spleen, bone marrow, liver, heart and kidney. The calculated analytical recovery excluding that portion attributable to bone marrow storage was 82 to 94% of the injected tracer. (auth)

12207 (N-71-34058) DETERMINATION OF THE RADIONUCLIDE CONTENT OF FECES AND URINE FROM ASTRONAUTS ENGAGED IN SPACE FLIGHT. Quarterly Research Report, July 1–October 5, 1969. Brodzinski, R. L.; Rancitelli, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Oct 1969. Contract AT(45-1)-1830. 25p. (NASA-CR-121861; BNWL-1183-2). NTIS.

Research efforts were directed primarily toward activation analysis of the astronauts' excreta to initiate studies involving the effects of the space environment on the mass balance of various elements by the body and delineate the future research in this area. The concentrations of 17 elements in the astronaut fecal samples from Apollos 7 and 9 and the calcium concentrations from Apollos 8 and 10 are reported. The search for possible Pm-147 contamination in the space capsule environment continued with an investigation of some filter media from the Apollo 10 air purification cannister. No Pm-147 contamination was observed in the spacecraft. A search for the presence of gaseous decay products of lunar uranium and thorium in the lunar atmosphere that might have become imbedded in the spacecraft skin during the lunar orbiting of Apollo 10 was attempted. The concentrations of the thorium and uranium daughter products in the sampled spacecraft skin were below detectable limits. (STAR)

12208 (N-71-34059) DETERMINATION OF THE RADIONUCLIDE CONTENT OF FECES AND URINE FROM ASTRONAUTS ENGAGED IN SPACE FLIGHT. Quarterly Research Report, April 8–June 30, 1969. Brodzinski, R. L.; Palmer, H. E.; Rancitelli, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Jul 1969. Contract AT(45-1)-1830. 49p. (NASA-CR-121860; BNWL-1183-1). NTIS.

The results are presented of a study to evaluate radiation activation during the course of Apollo 7, 8, 9, and 10 missions by counting the radionuclides excreted in the feces and urine of the astronauts. Observed radioisotopes were ^{7}Be, ^{22}Na, ^{24}Na, ^{40}K, ^{51}Cr, ^{59}Fe, ^{60}Co, and ^{137}Cs. The ^{51}Cr, ^{59}Fe, and ^{60}Co were from preflight injection; the ^{40}K and ^{137}Cs are naturally occurring or normally present; the ^{7}Be and ^{22}Na were both of normally occurring and cosmogenic origins; the ^{24}Na was cosmogenic. An evaluation of the data indicates that: (1) the Apollo 7 astronauts were exposed to protons with an average effective energy of 38 to 40 MeV, and that the radiation dose was 480+ or −310 mrads at the 65% confidence levels; (2) the Apollo 8 astronauts were exposed to protons of less than 38 MeV; (3) the radiation dose received by the Apollo 9 astronauts was less than 315 mrads; and (4) the radiation dose received by the Apollo 10 astronauts was 870+ or −550 mrads. Other studies are reported that include: neutron activation, analysis of feces and urine of astronauts, induced radioisotopes in spacecraft, promethium-147 in the space capsule environment, and calibration of the NASA whole-body counter. (STAR)

12209 SEX DIFFERENCES IN Cs METABOLISM IN MAN. Clements, C. F. (CNEN–CSN, Cassaccia, Italy); Mariani, A.; Santaroni, G. P. Health Phys.; 21: No. 5, 709-11(Nov 1971).

The ^{137}Cs body content due to fallout contamination was studied in two groups of healthy subjects, 19 male and 23 female, fed on similar diets. The ^{137}Cs and κ body contents were measured using a whole-body counter. The urinary excretion was collected and the ^{137}Cs content measured with a low background γ-ray spectrometer. Results are tabulated from which it is seen that the effective half time of ^{137}Cs is different for the male and female groups. It also appears that a metabolic difference between the sexes may exist for κ too. (UK)

12210 DISTRIBUTION OF ^{85}Sr IN CONCEPTUSES OF THE PREGNANT RAT. Wykoff, M. H. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-GEN-242. Radiat. Res.; 48: No. 2, 394-401(Nov 1971).

The distribution of the strontium burden in the whole product of conception (conceptus) of the rat with respect to its placental, embryonal or fetal, and fluid components was studied. This work employed 175 pregnant rats injected subcutaneously with ^{85}Sr. The gestational period observed was from the 13th to the 21st days inclusive (day 0 = day vaginal plug was observed). The effect of time after administration of the ^{85}Sr to the mother was determined by examining replicate groups on a daily basis for up to 5 days after injection. Maternal blood and uterus samples were assayed for ^{85}Sr. The concentration (percentage of dose per gram) was found to be apparently the same in the maternal blood and the uterus. This observation was independent of either the day of pregnancy

or the time elapsed after administration of the ^{85}Sr. From the 13th through the 15th days of gestation approximately 60% of the conceptus strontium was found in the fetal fluids and placenta. This value then decreased rapidly to approximately 2% of the conceptus strontium on the 21st day. (auth)

12211 LONG-TERM HEMATOLOGICAL EFFECTS OF INTERNAL EMITTERS IN BEAGLES. Dougherty, Jean H.; Rosenblatt, Leon S. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Radiat. Res.; 48: No. 2, 319-31(Nov 1971).

The hematological effects of five internal emitters injected into adult beagles were analyzed for 8 yrs postinjection. Five to seven dose levels were utilized per radionuclide ranging from near permissible levels to levels causing bone tumors. The main hematological alterations were depression of granular leukocytes and, to a lesser extent, erythrocytes. The depressions of leukocytes were dose dependent. Some recovery was noted at higher levels for polymorphonuclear leukocytes but not for lymphocytes. Transient depressions of blood cells were seen at lower dose levels. For any type of cell, minimal values were similar for all radionuclides and at comparable dose levels. Relative toxicities of the radionuclides to the hematopoietic system were related to deposition patterns and type of particle emission. (auth)

12212 ^{239}Pu(IV): ITS SUBCELLULAR DISTRIBUTION AND ASSOCIATION WITH FERRITIN IN THE CANINE LIVER. Bruenger, F. W.; Stover, Betsy J.; Stevens, W. (Univ. of Utah, Salt Lake City). Contract AT(1101)-119. Health Phys.; 21: No. 5, 679-87(Nov 1971).

Homogenates of livers from beagles injected with ^{239}Pu(IV) in citrate buffer and sacrificed at times ranging from 7 to 1539 days after injection were separated by differential centrifugation. Significant concentrations of plutonium were found in the subcellular particles, the cytosol, and the connective tissue. Concentrations in the mitochondrial–lysosomal fractions and microsomal fractions were the highest. Separation of the heavy mitochondrial fraction and of the light mitochondrial–lysosomal fraction by density gradient centrifugation showed that ^{239}Pu and acid–phosphatase are associated with protein of the same density. Most of the plutonium in the cytosol was bound to ferritin. Smaller fractions of plutonium were found in the very high molecular weight components (probably lipofuscin) and some with an unidentified low molecular weight material. Pure Pu-containing ferritin was separated by gel electrophoresis and by ultracentrifugation. The high concentration of plutonium in the microsomal fraction resulted in large part from contamination by ferritin that was heavily loaded with iron. (auth)

12213 IN VITRO ^{51}Cr AND ^{32}P-DFP LABELING OF GRANULOCYTES IN MAN. Dresch, C.; Najean, Y.; Beauchet, J. (Hopital Saint-Louis, Paris). J. Nucl. Med.; 12: No. 12, 774-84(Dec 1971).

Comparison between the disappearance half-time of ^{51}Cr and ^{32}P-diisopropylfluorophosphate (^{32}P-DFP) in vitro labeled granulocytes in man shows that ^{51}Cr $T_{\frac{1}{2}}$ is always longer than ^{32}P-DFP $T_{\frac{1}{2}}$ in normal subjects. This discrepancy has been studied by double-labeling methods and is due, on the one hand, to an in vivo elution of ^{32}P-DFP and, on the other hand, to a direct toxicity of ^{32}P-DFP for the labeled granulocytes. However, there is a good correlation between the $T_{\frac{1}{2}}$ of granulocyte disappearance from the circulating pool as measured by the two tracers in separate labeling in normal subjects and in some-pathological conditions. This fact makes possible a double-labeling method, ^{51}Cr on autologous granulocytes and ^{32}P-DFP on homologous normal granulocytes, for the study of leukocyte abnormalities, corpuscular and extra-corpuscular destruction, and leukocyte isoimmunization. (auth)

12214 LOCAL DOSES PRODUCED BY IRRADIATIONS WITH INCORPORATED ISOTOPES. Ryabukhin, Y. S.; Zaichik, V. E.; Tkachev, A. V.; Bogdanov, K. M.; Yanovskii, K. A. (Inst. of Medical Radiology, Obninsk, USSR). pp 277-80 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Autoradiography was used to study the distribution of ^{131}I in the thyroid gland. The dose at any given instant, and not the dose accumulated during the period when the radioisotope is acting upon the thyroid function was sought. As migration of the radioelement can occur from a point of high concentration to one of low concentration, the doses were averaged with respect to the dose rate. A double autoradiography technique using injected ^{131}I and the ^{128}I produced by the activation of the stable I isotope was used. The distribution of ^{128}I follows that of stable I. The distribution of stable and radioactive iodine incorporated in the different parts of the thyroid appears to be identical. (France)

12215 EFFECT OF RADON AND ITS DAUGHTER PRODUCTS, IN THE PRESENCE OF QUARTZ DUST, ON THE LUNGS OF RATS. Kilibarda, M.; Visnjic, V.; Leposavic, M.; (and others) (Institut Dragomir Karajovic, Belgrade). pp 281-5 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Sixty Wistar rats aged three months were divided into 4 groups. The first group was exposed to radon and its daughter products, the second group was exposed to quartz dust, the third group was exposed to radon and quartz dust, and the fourth group served as a control group. Histological examinations indicated that the combined action of radon and quartz dust does not modify the form of silicosis occurring, although it does accelerate its development. (France)

12216 REDUCTION BY ALGINATE OF THE ^{226}Ra BODY-BURDEN, MEASURED DIRECTLY IN VIVO WITH A Ge–Li DETECTOR IN MICE. Van der Borght, O.; Van Puymbroeck, S.; Colard, J.; Leduc, R. (CEN, Mol, Belgium). pp 367-73 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Body burdens of ^{226}Ra as low as 2.10^{-2} μCi in mice can be directly measured in vivo using a Ge–Li detector. A device for making measurements automatically with up to 30 mice is described. This technique also allows the biological decay of ^{226}Ra to be studied. The intestinal absorption of Ra is reduced 10 to 50 times when intubation of a $RaCl_2$ solution is performed on mice fed with an alginate–agar mixture, as compared with mice fed with agar alone. The biological decay of ^{226}Ra in mice and the effect of alginate on this decay were studied. The importance of the presence of food or other materials in the gastrointestinal tract is emphasized, when a per cent absorption has to be established. The effects of starvation, high viscosity alginate, low viscosity alginate, agar, and standard diet were studied. The use of the nontoxic alginate is suggested as a preventive agent in any situation where some risk of gastrointestinal contamination exists. (France)

12217 ENDOGENOUS ZINC EXCRETION AND ^{65}Zn METABOLISM IN HOLSTEIN CALVES FED INTERMEDIATE TO HIGH BUT NONTOXIC ZINC LEVELS IN PRACTICAL DIETS. Miller, W. J.; Wells, E. S.; Gentry, R. P.; Neathery, M. W. (Univ. of Georgia, Athens). J. Nutr.; 101: No. 12, 1673-81(Dec 1971).

Zinc and ^{65}Zn metabolism, from a single intravenous dose (given 7 days after diets were initiated) were studied in Holstein bull calves fed a practical diet containing 38 ppM zinc or the same diet with 200 or 600 ppM supplemental zinc (zinc oxide). The supplemental zinc increased endogenous fecal ^{65}Zn excretion by 30% with 200 ppM added zinc having as much influence as 600 ppM. The supplemental zinc has a very variable effect on ^{65}Zn distribution in different tissues 14 days after dosing. With some tissues including testicle, rumen wall and abomasum (fundic) each increase in dietary zinc reduced ^{65}Zn content. In muscle, dietary zinc level had no effect on ^{65}Zn concentration. Adding 200 ppM zinc to the diet increased ^{65}Zn and stable zinc in pancreas, liver and kidney; however, a further increase to 638 ppM caused very large increases in these tissues indicating a breakdown in homeostatic control for both injected and absorbed zinc. With the 638 ppM diet smaller increases in ^{65}Zn occurred in bone and small intestine. Serum ^{65}Zn increased with the high zinc diet. Except for muscle, where there was no change, specific activity in every tissue studied decreased with each increase in dietary zinc. (auth)

12218 ^{45}Ca AND ^{85}Sr ABSORPTION IN IRRADIATED CHICKENS. Mraz, Frank R. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.). Contract AT-40-1-Gen-242. Health Phys.; 22: No. 2, 165-8(Feb 1972).

White Leghorn pullets at 4 weeks and 1 yr of age were exposed to 800 R of gamma rays at dose rates of 5 and 25 R/min. Oral administration or perfusion of the small intestine with ^{45}Ca and ^{85}Sr was made 24 hr later with both groups and 7 days later with the 4-week-old pullets. The orally dosed birds were sacrificed 72 hr after dosing while the perfused birds were sacrificed im-

mediately after perfusion. Irradiation tended to reduce absorption and tibial deposition of ^{45}Ca and ^{85}Sr in all the groups perfused and most of those orally dosed. Recovery in absorption and deposition of the radionuclides in the 4-week-old birds was not complete 7 days after irradiation. (auth) (UK)

12219 DERIVATION OF RETENTION EQUATIONS OF CESIUM IN HUMAN INTERNAL ORGANS BY COMPARTMENTAL ANALYSIS. Fujita, Minoru (Japan Atomic Energy Research Inst., Tokai). Health Phys.; 22: No. 2, 125-34(Feb 1972).

Retention equations of Cs in single internal organs in the human body were derived by compartmental analysis. A 5-compartment mammillary system was adopted as the model for Cs metabolism, because it could explain the experimental data on the retention of Cs in the single internal organs in rats. The model for humans was derived from the rat model by modifying the rate constants of it to fit human data but leaving the type of the model unchanged. The retention equations in the muscle, testes, liver and bone in the human body were derived. (UK)

12220 MEASUREMENT OF THORON IN THE BREATH OF DOGS ADMINISTERED INHALED OR INJECTED ThO_2. Ballou, J. E.; Hursh, J. B. (Univ. of Rochester, N. Y.). Health Phys.; 22: No. 2, 155-9(Feb 1972).

Breath thoron was measured in beagles following inhalation or injection of ^{228}Th-enriched ThO_2. Immediately after exposure, thoron release to the breath was less efficient from inhaled ThO_2 than from ThO_2 injected intravenously. After approximately 2 weeks, when the inhaled burden was localized in the lungs, the efficiency of thoron release to the breath was increased by one-half and exceeded that following other modes of administration. The lowest release values were found following intramuscular injection. The ratio relating thoron in the lung space to ^{228}Th in the lung remained fairly constant for a period of 150 days after inhalation exposure. Applying this ratio to periodic breath thoron measurements, the half-time for clearance of ThO_2 from the lung was estimated to be 350 days. (auth) (UK)

12221 EFFECT OF PARTICLE SIZE ON ORGAN DISTRIBUTION OF RADIOACTIVE MATERIAL DEPOSITED IN THE LUNGS. Parsont, M. A.; Holley, W. L.; Burnett, W. D. (Sandia Labs., Albuquerque, N. Mex.). Health Phys.; 22: No. 2, 143-8 (Feb 1972).

If solubility as a function of particle size is considered, both the clearance of radioactive particulate material from the lung and the dose to the lung may differ considerably from the values predicted by the ICRP Task Group on Lung Dynamics. For small particles, ≤ 1 μm, the lung dose decreases and the dose to other internal organs increases. This has the effect of changing the critical organ from the lung to another organ or tissue, depending upon the propensity of this organ or tissue to concentrate, retain, or react to the radiation. Doses to the liver and the kidneys also become larger than the dose to the lung. It is recommended that the ICRP incorporate the above considerations in the lung clearance model. (UK)

12222 INHALED PARTICLES III. VOLUMES I AND II. Proceedings of an International Symposium, London, 14–23 September 1970. Walton, W. H. (ed.). Old Woking, Eng.; Unwin Brothers Limited (1971). 1090p. $40.00. (In several languages). (CONF-700931–(Vol. 1 and 2)).

The ninety-one papers presented at the conference were divided into sections entitled: Inhalation and deposition. Pulmonary clearance. Biological reactions to dust. Biological reactions—ancillary factors. Immunological factors. Radiology and physiology of pneumoconiosis. Dust in human lungs. Characteristics of airborne dusts. Epidemiological studies. Dust sampling and standards. Separate abstracts were prepared for the nine papers in scope. (UK)

For abstracts of individual papers see: 12223–12225, 12273, 12287, 12334, and 12508–12510.

12223 INHALATION STUDY OF METABOLISM OF INSOLUBLE URANIUM COMPOUNDS. Galibin, G. P.; Parfenov, Yu. D. (Inst. of Biophysics, Moscow). pp 201-7 of Inhaled Particles III. Vols. I and II. /Walton, W. H. (ed.). Old Woking, Eng.; Unwin Brothers Ltd. (1971).

From third international symposium on inhaled particles; London, England (14 Sep 1970).

When rats are subjected to single inhalation (10 mg/m^3 and 30 mg/m^3) of insoluble uranium compounds—ammonium diuranate ($(NH_4)_2U_2O_7$), uranium tetrafluoride (UF_4) and uranium octoxide (U_3O_8), 14 to 25% of the total inhaled amount is retained in the animal's body. The principal organ for deposition of these uranium compounds is skeleton. Biological half-life of uranium for the skeleton is 310 to 375 days. Lungs, kidneys and liver are other organs of retention. The deposition level of ammonium diuranate and UF_4 in the liver is 3 to 5 times as high as that of U_3O_8. The mobilization of uranium from the lungs is described by the sum of four exponentials. Effective half-life of uranium for the liver and kidneys is not more than 30 days. A similar pattern of uranium metabolism is obtained for chronic inhalation of these compounds. Estimation of uranium content in the body is based on concentration in the urine. (auth)

12224 BIOCHEMICAL ASPECTS OF THE EARLY ALVEOLAR RETENTION OF LIQUID RARE EARTH AEROSOLS. Pasquier, Ch.; Lefebvre, J. C.; Ehrhart, J. C. (CEA, Fontenay-aux-Roses, France). pp 301-9 of Inhaled Particles III. Vols. I and II. /Walton, W. H. (ed.). Old Woking, Eng.; Unwin Brothers Ltd. (1971). (In French).

From third international symposium on inhaled particles; London, England (14 Sep 1970).

A lipoprotein typical of the alveolar lining was isolated from endobronchial washing liquids obtained from rats and monkeys; this lipoprotein rich in glycolipids and free fatty acids had a lipidic composition widely different from the whole alveolar film. The part it played in the retention of unpolymerized lanthanum was demonstrated in vitro by polyacrylamide disc electrophoresis and in vivo by combined continued paper chromatography and electrophoresis. The stability of the lanthanum-lipoprotein complex was tested by DTPA and its contribution in respiratory contamination discussed. (auth)

12225 STUDIES OF INHALED RADON DAUGHTERS, URANIUM ORE DUST, DIESEL EXHAUST, AND CIGARETTE SMOKE IN DOGS AND HAMSTERS. Stuart, Bruce O.; Willard, Donald H.; Howard, Edwin B. (Battelle-Northwest, Richland, Wash.). pp 543-8 of Inhaled Particles III. Vols. I and II. /Walton, W. H. (ed.). Old Woking, Eng.; Unwin Brothers Ltd. (1971).

From third international symposium on inhaled particles; London, England (14 Sep 1970).

The incidence of lung cancer in uranium ore miners on the Colorado Plateau has risen to six times that of non-miners. Although the primary carcinogenic agent is generally accepted to be the inhaled short-lived radioactive decay products of radon, the miners are routinely exposed to several other hazardous airborne contaminants, including ore dust and diesel-engine exhaust fumes. In addition, 97% of those uranium miners who have developed lung cancer have histories of cigarette smoking. A program involving inhalation exposures of experimental animals was undertaken to determine the relative effectiveness of the principal mine air contaminants in the production of pulmonary fibrosis, emphysema, or neoplastic changes. Six groups of 100 hamsters each are being exposed in life-span studies for 6 h daily to radon daughters, ore dust, and/or diesel exhaust fumes. The possible synergistic action of radon daughters and cigarette smoking in the development of lung cancer in uranium miners is being studied using beagle dogs. Three groups of 20 dogs each are receiving daily exposures to 4 hr of 600 Working Levels of radon daughters plus ore dust, exposure to cigarette smoking over 16 h periods, 7 days per week, and exposure to both radon daughters and cigarette smoking; 9 dogs serve as controls for hematology, physical examination and radiographic examination. Two dogs in each group receive lung washings for lung exfoliative cytology studies. The current results of these long-term multiple exposure studies with experimental animals are discussed. (auth)

12226 SIMPLIFIED METHOD FOR EVALUATING THE HEALY PLUTONIUM EXCRETION EQUATION. Nelson, I. C. (Battelle Memorial Inst., Richland, Wash.). Health Phys.; 22: No. 2, 191-3(Feb 1972).

The Healy extension of the Langham Model for evaluating the systemic burden of Pu, resulting from an inhalation of compounds which are not all immediately transferred to the blood, involves a function of time which is not integrable in simple terms. By assuming that the rate constant λ describing the disappearance of Pu from the urinary pool is solely due to the part taken up by body fluids and that ciliary action is negligible, and by a change in the variable of integration, generating functions G(R) and F(λR) are derived whose product gives $E_u(\lambda R)$. R is the time in days after initial plutonium uptake into the lung to the time of urine sampling and E_u is the amount of Pu in the 24 hr sample. The functions G and F are tabulated and plotted and examples of their use in evaluating E_u are given. The functions also facilitate the comparison of a number of data points collected over a period of time with a complete plot of $E_u(\lambda R)$. (UK)

12227 INTESTINAL UPTAKE AND WHOLE-BODY RETENTION OF ^{141}Ce BY SUCKLING RATS. Inaba, Jiro; Lengemann, F. W. (New York State Veterinary Coll., Ithaca). Contract AT(30-1)-2147. Health Phys.; 22: No. 2, 169-75(Feb 1972).

Ingested ^{141}Ce was retained to a much greater extent by suckling than by 26-day old or 43-day old rats. This greater retention was the result of a hold-up of ^{141}Ce in the lower portions of the small intestine. Microautoradiographs showed ^{141}Ce in these intestinal cells possibly associated with mucin vacuoles. Data are presented suggesting that ^{141}Ce tends to remain in the epithelial cells until lost from the body by sloughing of the cells from the tips of the villi. The uptake and retention of ^{141}Ce were also affected by diet. (auth)

12228 REDUCTION IN THE ABSORPTION AND RETENTION OF STRONTIUM IN RATS. Slat, B. (Inst. for Medical Research, Zagreb); Kostial, K.; Harrison, G. E. Health Phys.; 21: No. 6, 811-14(Dec 1971).

Dietary supplements which reduce the absorption and retention of strontium without affecting the turnover of essential elements could well provide a most effective remedial measure should the content of ^{90}Sr in the human diet become dangerously high. Rats were fed a stock diet supplemented with calcium phosphate and sodium alginate, separately and simultaneously, over a period of 4 to 5 months. Observations were made at intervals on the growth rate and on visual and histological abnormalities in some body tissues. No toxic effects were observed. The absorption and skeletal retention of calcium for rats on the combined supplements remained almost unchanged but the absorption and retention of strontium were reduced 7-fold. (TSS) (UK)

12229 COMPARATIVE STUDY OF THE ABSORPTION OF Sr AND Ca BY IRRIGATED RICE AS A FUNCTION OF THE QUANTITIES CONTAINED AND THE Sr/Ca RATIO OF THE NUTRIENT SOLUTION. Myttenaere, C.; Masset, M. (European Atomic Energy Community, Ispra, Italy). Radioprotection; 6: No. 3, 209-15(1971). (In French).

A study was made of Sr and Ca discrimination in irrigated rice as a function of two variables: the Sr to Ca ratio, and the total amount of Sr and Ca in the nutrient medium. A study under water culture conditions demonstrated that the observed ratio is a function of both variables. As it rises, the mineral sap becomes progressively depleted in Sr; the conducting organs are relatively richer in Sr than the leaves and grain. The observed ratios for the caryopse are considerably less than one, demonstrating a relatively large amount of Ca. (France)

Radiation Effects

Refer also to abstracts 12257, 12314, 12350, 12353, 12439, 12503, and 12576.

12230 (AERE-R-6951) RELATIVE BIOLOGICAL EFFECTIVENESS OF TRITIUM IN AQUEOUS SOLUTIONS OF RIBONUCLEASE. Richold, P. H. C. V.; Gibson, J. A. B.;Marshall, M. (Atomic Energy Research Establishment, Harwell (England)). Nov 1971. 5p. Dep. NTIS (U. S. Sales Only). UK 9p.

Aqueous solutions of ribonuclease were irradiated using ^{60}Co γ and tritiated water under anoxic and aerobic conditions. The residual enzymic activity was determined using cytidine-2,3-cyclic monophosphoric acid. Exponential survival curves were obtained under all conditions. The R.B.E. for tritium (with respect to ^{60}Co) does not differ significantly from unity (0.94 ± 0.11). It was also shown that oxygen had little or no protective effect (O.E.R. = 0.97 ± 0.02). (auth)

12231 EFFECT OF IONIZING RADIATION ON HAEMOGLOBIN OF MARINE LAMELLIBRANCHS. Patel, S.; Patel, B. (Bhabha Atomic Research Centre, Bombay). Marine Biol.; 10: No. 3, 272-9(Aug 1971).

The effect of ionizing radiation on the iron-linked protein (haemoglobin) of the marine lamellibranchs Anadara granosa (Linn.) and Cardita antiquata (Lam.) from Bombay waters, India is discussed. Purified haemoglobin solutions were exposed to a ^{60}Co source delivering a dose of about 4,600 rad/min, at the sample irradiation point. Radiation damage or degradation was measured spectrophotometrically by studying changes in the absorption spectra following irradiation in the presence and absence of oxygen. Exposure to ionizing radiation in general caused a decrease in absorption of both haemoglobins, irrespective of location, viz extra-versus intracellular, at Soret (412 mμ), β (540 to 42 mμ) and α (574 to 76 mμ) peaks, and an increase in absorption at 510 and 630 mμ. Upon exposure to a higher dose, O_2Hb of C. antiquata showed an increase in absorption at the protein peak (280 mμ); exposure to a lower dose, however, resulted in decreased absorption. Furthermore, the changes following irradiation were dependent upon the initial state of the pigment. Oxyhaemoglobin, when exposed to radiation, oxidized to hemiglobin, and hemiglobin reduced to oxyhaemoglobin. The extracellular haemoglobin of high molecular weight (3×10^6) of the false cockle C. antiquata was found to be extremely radioresistant, whereas intracellular haemoglobin of low molecular weight (74,000) of the arcid clam A. granosa was highly radiosensitive, since it could not be exposed to doses exceeding 18,000 R. (auth)

12232 INVESTIGATION OF THE BIOLOGICAL EFFECTS OF RADIOISOTOPES ON THE TRANSFER RIBONUCLEIC ACIDS OF CHICKEN EMBRYO. Szabo, L. (Sugaregeszseguegyi Kutato Intezet, Budapest). Izotoptechnika; 14: No. 6, 42-8(Jun 1971). (In Hungarian).

The in vitro study of the amino-acid bonding capacity of control and ^{32}P-labeled transfer ribonucleic acids, prepared from cells of chicken embryos, is presented. (auth)

12233 REDUCTIVE DEAMINATION OF OLIGOPEPTIDES BY SOLVATED ELECTRONS IN AQUEOUS SOLUTION. Simic, M.; Hayon, E. (Army Natick Labs., Mass.). Radiat. Res.; 48: No. 2, 244-55(Nov 1971).

The reaction rate constants of the hydrated electron ($e^-_{(aq)}$) were determined, by pulse radiolysis, for a number of oligopeptides, including oligoglycines, the N-acetyl derivatives, the amides, and the esters. These rates were determined at various pH values in order to examine the effect of protonation on the reactivity of the molecule towards $e^-_{(aq)}$. The results indicate that the rates of reaction depend on the cooperative effect of the peptide, amino, and carboxyl groups, and on the overall charge of the molecule. It is suggested that the peptide bonds are the site of attack of the $e^-_{(aq)}$. Deamination (80 to 90%) is shown to be the final result of the reaction of $e^-_{(aq)}$ with simple oligopeptides having a protonated terminal amino group. Similar effects were observed for the amides and esters of oligoglycines. The deaminated radicals were observed and found to have characteristic transient optical absorption in the 400-nm region. Deprotonation of the end amino group leads to a drop in the reactivity towards $e^-_{(aq)}$ and a change in the resulting transient species. The electron adducts of glycine methyl ester and diglycine ethyl ester were observed, and the acid base properties of the radicals $NH_2CH_2\underset{\displaystyle OH}{\underset{|}{C}}OCH_3$ and $H-Gly-NHCH_2\underset{\displaystyle OH}{\underset{|}{C}}OC_2H_5$ were determined, pK 11.1 and 9.7, respectively. (auth)

12234 RADIATION INDUCED CHANGES IN THE PROPERTIES OF THE ACID SOLUBLE RAT SKIN COLLAGEN SOLUTION. Dancewicz, Antoni M.; Jelenska, Maria M.; Majewska, Maria R.; Mazanowska, Anna (Inst. of Nuclear Research, Warsaw). Nukleonika; 16: No. 5-6, 301-9(1971).

The radiation-induced changes in the viscosity, denaturation temperature, thermal aggregation and subunit composition of the acid soluble rat skin collagen solution were measured in the presence and absence of air in the range up to 80 krad. Irradiation of the deaerated solution resulted in an increased intrinsic viscosity accompanied by an increased content of higher molecular weight components. Two denaturation temperatures, decrease in the intrinsic viscosity and less pronounced changes in composition of collagen were observed after irradiation in the presence of air. The extent of thermal aggregation was lowered under both conditions of irradiation. It has been concluded that moderate doses of radiation in the absence of air induce in collagen crosslinks which are preferably of intramolecular nature, intermolecular crosslinking being pronounced at higher irradiation doses. (auth)

12235 EFFECT OF RADIATION-INDUCED BINDING ON THE SECONDARY STRUCTURE OF DNA. Yamamoto, Osamu (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 81-92(1971). (In Japanese).

Effect of radiation-induced binding of DNA with tryptophan or serum albumin on the secondary structure of DNA was studied. When double stranded DNA was irradiated with γ rays in the presence of tryptophan or serum albumin, the Tm curves showed the difficulty of melting to single strand. Single stranded DNA was also irradiated in the presence of the aromatic amino acid or the protein. After renature treatment by reheating and slow cooling the Tm was measured. Marked abnormality was observed with very irregular patterns. (auth)

12236 ACTION OF α AND β AMYLASES ON γ-IRRADIATED STARCH. Tollier, M. T.; Guilbot, A. (Institut National de Recherches Agronomiques, Massy, France). Ann. Technol. Agr.; 20: No. 1, 61-73(1971). (In French).

The action of α and β amylases on the starch of potatoes and maize was studied in relation to the different radiation treatments to which these products had been subjected. The investigation was divided into two parts: as a function of the irradiation dose for two

hydrations of the starch at the time of the irradiation, as a function of the hydration of the starch at the time of the irradiation; a 25 millirad dose was used. It is also shown that the action of α and β amylase in the crude state after the irradiation depends chiefly upon the state of the dispersion of the macromolecular portion and the proportion of modified anhydroglucose units in the macromolecules blocking the enzyme action. (France)

12237 MECHANISM OF THE RADIATION-INDUCED INACTIVATION OF RIBONUCLEASE IN DILUTE AQUEOUS SOLUTION. Adams, G. E. (Mount Vernon Hospital, Middlesex, Eng.); Willson, R. L.; Bisby, R. H.; Cundall, R. B. Int. J. Radiat. Biol.; 20: No. 5, 405-15(1971).

Pulse radiolysis data from ribonuclease solutions were used to help interpret the mechanism of the radiation-induced inactivation of this enzyme. Activity measurements showed that in γ-irradiated dilute aqueous solution, hydrated electrons did not contribute to the inactivation process. In deoxygenated solution, 90 percent of the inactivation process was due to reactions of OH radicals with the remainder attributable to reactions of hydrogen atoms. Pulse radiolysis studies showed the formation of three transient spectra which were assigned respectively to reactions of OH, H and e^-_{aq} with the enzyme. It was concluded that the spectrum of the OH-induced transient contained contributions from OH-adduct spectra of the ring-containing amino acids and that some of the short-lived species were involved in the initial stages of the inactivation process. (UK)

12238 EFFECT OF X RAYS ON LIPIDS, PHOSPHOLIPIDS, AND CHOLESTEROL OF THE MOUSE TESTIS. Kochar, Nirmal K.; Harrison, R. G. (Univ. of Liverpool). J. Reprod. Fert.; 27: No. 2, 159-65(Nov 1971).

The testes of mature male A_2G mice were exposed to a single dose of 1000 R of x-rays, and examined at varying intervals up to 146 days after irradiation. Lipids, phospholipids and cholesterol were studied in the control and irradiated mice using histochemical techniques, and estimated quantitatively by the paper weight technique. The relative proportion of lipids per unit area of testis decreased 2 and 6 days after exposure, but increased dramatically from 20 to 72 days; by 146 days, it had nearly returned to the normal level. The relative proportion per unit area of tissue containing phospholipid decreased 2 and 10 days after exposure, steadily rose at 12 days and after until 103 days, and returned to normal at 146 days. The relative proportion of cholesterol increased markedly after 20 days but at 103 and 146 days, it fell to the control level. The significance of these findings is discussed. (UK)

12239 INACTIVATION BY GAMMA RAYS OF FUNCTIONAL PROPERTIES OF TRANSFER RIBONUCLEIC ACIDS OF ESCHERICHIA COLI (PHENYLALANINE AND LYSINE). Ekert, Bernard; Latarjet, Marie-France (Institut du Radium, Paris). Int. J. Radiat. Biol.; 20: No. 6, 521-40(1971). (In French).

The effects of γ-rays on various functions of certain specific t-RNA's of E. coli were studied. The inactivation of these functions generally increased exponentially with the dose. No sensitization by oxygen was observed, the radiosensitivity of these functions being increased in the absence of oxygen. It was suggested that radiochemical inactivation of t-RNA functions occurred as a consequence of the breakage of a phosphodiester bond within the site responsible for each function. The inactivation curves for the following properties were compared: amino-acid acceptance, adaptation to form a m-RNA-ribosome-aminoacyl-t-RNA complex; amino-acid transfer to a growing polypeptide chain, polypeptide synthesis according to Nirenberg's technique. In all cases, adaptation activity showed the same radiosensitivity as the transfer activity. For each t-RNA the acceptance properties were more sensitive than adaptation and transfer functions. For lysyl-t-RNA the overall sensitivity (for acceptance + adaptation + transfer) was the same as for acceptance alone. In contrast for phenylalanyl-t-RNA the overall sensitivity was larger than for acceptance alone. It was suggested that for phenylalanyl-t-RNA there was a small, for lysyl-t-RNA a complete overlap of the functional sites. (UK)

12240 ALPHA-RAY INDUCED BREAKS IN THE DNA OF ESCHERICHIA COLI. Wilkins, R. J. (Wakari Hospital, Dunedin, New Zealand). Int. J. Radiat. Biol.; 20: No. 5, 497-500(1971).

Experiments were made to study the ratio of reparable isolated single strand breaks to irreparable double strand breaks (the breaks ratio), produced in DNA by irradiation of Escherichia coli with α rays of LET 200 keV/μm and x rays of LET 4.9 keV/μm. The average number of breaks were calculated from the pre- and postirradiation DNA molecular weights obtained from sedimentation profiles. The yields for α and x radiation respectively were 0.19 and 0.08 double strand breaks per 100 eV of dose absorbed in the DNA. When allowance was made for the contribution of double-strand breaks to the total single-strand breakage in the DNA it was found that α rays yielded 0.24 isolated single-strand breaks per 100 eV absorbed dose compared with 0.62 for x rays. For α rays the breaks ratio was 1.2:1, whereas for x rays a 7.8:1 ratio was obtained. (UK)

12241 DEPRESSIVE EFFECT OF ADENINE ON DEGRADATION OF ADENINE NUCLEOTIDES IN X IRRADIATED RAT THYMOCYTES. Araki, Kimiko; Ohyama, Harumi; Yamada, Takeshi (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Radiat. Biol.; 20: No. 5, 417-26(1971).

Addition of 5 mM adenine to 1 kR-irradiated rat thymocytes restored the ATP-content to normal level. Mechanisms underlying the restoration were investigated by using ^{14}C-adenine and ^{32}P-orthophosphate. ^{14}C-adenine was incorporated into ATP and the ATP thus labeled degraded to hypoxanthine. Adenine in 5 mM concentration did not enhance the ATP synthesis from ^{14}C-adenine, but depressed markedly the degradation of ATP to hypoxanthine. It was concluded that restoration of ATP level by adenine resulted from its depressive effect on degradation of adenine nucleotides. (UK)

12242 DEPOLYMERIZATION OF MUCOPOLYSACCHARIDES BY X RAYS AND FAST NEUTRONS. Aarnoudse, M. W.; Lamberts, H. B. (Univ. of Groningen, Netherlands). Int. J. Radiat. Biol.; 20: No. 5, 437-45(1971).

14 MeV neutrons showed a RBE smaller than 1 with reference to 200 kVp x-rays for viscosity-decrease of synovial fluid and for increase of water-permeability of connective-tissue membranes. In synovial fluid the influence of oxygen and a number of chemoprotectors on the irradiation-effects was less in the case of the radiation with the higher LET. The OER was smaller than 1 for both types of radiation. Cystamine, 5-hydroxytryptamine, (5HT), and sodium sulphite solutions were tested. A 0.01 M solution of 5HT had a sensitizing effect on the permeability of connective tissue membranes with both types of radiation but in synovial fluid showed a protective action. (UK)

12243 SINGLE-STRAND BREAKS IN GAMMA-IRRADIATED ϕX 174 DNA INDUCED BY EXPOSURE TO ALKALI. Achey, P. M.; Billen, D.; Beltranena, H. P. (Univ. of Florida, Gainesville). Int. J. Radiat. Biol.; 20: No. 5, 501-4(1971).

Replicative Form 1, (RF 1), DNA, labeled with ^{3}H-thymine was prepared by growing ϕX 174 DNA on the thymine-requiring host Escherichia coli HF 4704. Irradiation was carried out at a dose rate of 5000 rads/min with a ^{60}Co source over a range of 0 to 108.3 krads. It was found that the quantity of strand breaks, (as indicated by the conversion of RF 1 to RF 11), was greater when analysis was performed on alkaline sucrose gradients rather than neutral sucrose gradients. At a dose rate of 0.8 krads at room temperature, the additional conversion by alkaline exposure was between 28.0% and 30.1%. At doses of 90.2 krads and 108.3 krads, at a temperature of −196°C, the additional conversion was between 6.5% and 10.1%. (UK)

Immunology

Refer also to abstract 12498.

12244 (RLO-2226-T-3-12) IMMUNOLOGIC STIMULI IN RELATION TO LEUKEMOGENESIS. I. POTENTIATION OF RAUSCHER VIRAL LEUKEMIA BY FREUND'S ADJUVANTS. Siegel, Benjamin V.; Morton, Jane I. (Oregon Univ., Portland. Medical School). [1971]. 18p. Dep. NTIS.

Accelerated erythroleukemia and deaths occurred in BALB/c mice injected intraperitoneally with complete Freund's adjuvant 10 days before to 3 days after inoculation with Rauscher virus. Increased leukemic deaths were also noted in mice pretreated with incomplete Freund's adjuvant. Complete adjuvant injection 3 days before exposure to 500 R irradiation resulted in a ten-fold increase in endogenous spleen colony formation suggesting stimulation of stem cell proliferation. Adjuvant administration at various times prior to intraperitoneal or intravenous immunization with sheep erythrocytes produced 2- to 3-fold increases in peak numbers of spleen plaque-forming cells indicative of enhanced humoral antibody formation. Work from this and other laboratories would suggest that an augmented viral target cell population rather than immunological enhancement is responsible for the potentiation of Rauscher leukemogenesis by adjuvant treatment. (auth)

12245 STUDY ON IMMEDIATE RETRANSPLANTATION OF X-IRRADIATED MANDIBULAR PIECES. 2. EXPERIMENTAL RESEARCH. Sato, Kimihiko (Kyushu Dental Coll., Fukuoka). Kyushu Shika Gakkai Zasshi; 24: No. 4, 422-37(Nov 1970). (In Japanese).

According to Hirakawa and his associates, the healthy bone chips obtained from areas surrounding osseous lesions of the mandible and alveolar bone were used to fill defects following enucleation of bone lesions. But they did not apply to malignant tumors because of the danger of transportation and survival of tumorous cells. Bone block and bone chips, after 5000 R single irradiation, were immediately transplanted into the artificial bony cavity in dog's mandible. From 7 to 10 days to 20 to 30 days after operation, resorption of implants was observed both in the bone block group and the bone chips group. Atrophy and disappearance of osteocytes of the implant was seen more in the irradiated case than the control case. Immature bone formation in the bone chips group appeared at about 20 days after operation and it was seen early in comparison with the bone block group. Moreover, vigorous neogenesis of bone fused with and gradually surrounded the implants and led to the restoration of the bony defect. The bony healing was nearly complete in 60 days and was accomplished perfectly in 120 days after operation, but the healing process in the irradiated case was delayed for each step compared with the control case. The healing process of the dog's retransplanted mandibular pieces after 5000 R single irradiation was similar to the findings of the control case but slightly delayed. It was recognized that the irradiated mandibular pieces played the part of implant material finally. (auth)

12246 COMPARATIVE STUDIES OF THE EFFECTS OF 14-MeV NEUTRONS AND 30 kVp X RAYS ON THE MOUSE IMMUNE RESPONSE TO SHEEP RED CELL ANTIGENS. Gregory, C. J.; Ebert, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 20: No. 3, 291-6(1971).

It is stated that comparatively little has been reported about the effects of high-LET radiations on the cells responsible for immunocompetence. Such information is of interest in that immune responses have been shown to play a significant role in controlling the growth of malignant cells. The results of a comparative study of the effects of 14 MeV neutrons and 300 kVp x-rays on the capacity of mice to produce a humoral antibody response to sheep red cell antigens are here reported. The number of specific antibody-forming cells detected in the spleen at the peak of the response was used to provide a quantitative measure of immune responsiveness. The neutrons were produced by the T(d,n)^{4}He reaction and the x-ray doses were delivered by a 300 kVp set, the respective dose rates being 18 to 25 R/min. and 118 R/min. The sheep red cells were injected intravenously 24 hrs after the irradiation. The relationship between neutron or x-ray dose and the survival of plaque-forming cells responsiveness is shown graphically both for direct and indirect plaque-forming cells. The I-PFC response appeared to be somewhat more sensitive than the D-PFC response to x-rays, but both responses were equally sensitive to neutron radiation, accounting for the slightly higher neutron/x-ray RBE values obtained for the D-PFC response. Mechanisms are discussed. (UK)

12247 IMMUNOPATHOLOGY. Anderson, Robert E. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 563-6(Dec 1971).

The immunologic consequences of exposure to ionizing radiation are extremely complex and dependent upon a large number of seemingly divergent factors. Putative relationships between exposure status and immunologic dysfunction will probably in general be confined to selected subsegments of the population at risk. The positive relationships documented to date in this regard have followed this pattern: Proximally located Hiroshima males showed an increased prevalence of tuberculosis during the period 1950 to 1960; Hiroshima survivors under 30 years of age at the time of the bomb with scars secondary to thermal burns and located 0 to 1299 meters from the hypocenter tolerated splenic irradiation poorly. Other morphologic evidence of dysfunction has been sought. The absence of a positive relationship is tentatively attributed to the size of many of the subcomponents of the autopsy series, which thus far has precluded appropriate analysis of individual components. (auth)

12248 HUMORAL ANTIBODY RESPONSE OF IRRADIATED MICE TREATED WITH CHEMICAL RADIOPROTECTORS. Sassen, A.; Hashmi, Q.; Mattelin, G.; Maisin, J. R. (CEN, Mol, Belg.). Strahlentherapie; 142: No. 2, 252-7(Aug 1971).

A radioprotective mixture given to 650 R x-irradiated mice affords a better immunological response than that observed in the non-protected irradiated mice, independently of the nature of the antigens or the time of their administration. However, even with protection, there is a marked depression of the antibody response. With rat erythrocytes, the maximum susceptibility occurs when the antigen is given 3 days before irradiation and protection. In our experimental conditions, the small radioprotective effect on the immune system does not seem to be due to a specific decrease of one cell system, since no better antibody response is observed after injection of macrophages, bone marrow, or thymus. Hemolysins are less depressed than hemagglutinins. The recovery of the immune potential of irradiated and protected mice occurs between 1 and 2 months after x-ray treatment. The radioprotective mixture given alone has no influence on the antibody response. (auth)

12249 DIFFERENTIAL EFFECT OF γ IRRADIATION ON THE SENSITIZING AND EFFECTOR STAGES OF ANTIBODY DEPENDENT LYMPHOCYTE MEDIATED CYTOTOXICITY. Pudifin, D. J. (Univ. of Natal, South Afr.); Harding, B.; MacLennan, I. C. M. Immunology; 21: No. 5, 853-60(Nov 1971).

The effect of whole body γ irradiation of donors on the cytotoxic action of spleen cells from specifically sensitized rats towards the xenogeneic Chang cell was studied. The target cells in this model are killed by effector lymphocytes which are triggered into cytotoxic activity by IgC complexed with target cell antigens. A separate population of lymphocytes produces the sensitizing antibody. It was shown that production of sensitizing antibody could not be induced within 16 days after 850 rad whole body irradiation. The cytotoxic effector population, however, despite initial severe depletion, neared complete recovery by this time. The implications of this differential effect are discussed. (UK)

12250 RESTORATION OF AUTOIMMUNE THYROIDITIS IN BURSECTOMIZED-IRRADIATED OS CHICKENS BY BURSA CELLS. Nilsson, L. A.; Rose, N. R. (State Univ. of New York, Buffalo). Immunology; 22: No. 1, 13-23(Jan 1972).

Chickens were subjected to combinations of bursectomy, thymectomy, and x-irradiation followed by restoration with autologous bursa cells. The influence on the incidence of spontaneously occurring thyroiditis was studied. Less pronounced thyroiditis and thyroglobulin antibody formation was found in the bursectomized and bursectomized-irradiated but not in the thymectomized chickens. Bursectomized-irradiated chickens which had been reconstituted with autologous bursa cell suspensions showed total restoration of the thyroiditis. No restoration of thyroglobulin antibody forming capacity and only partial restoration of immunoglobulin level was observed. It is suggested that a dual function of the bursa with regard to thyroid autoimmunity in OS chickens, one humoral and possibly hormonal, which is essential for thyroglobulin antibody formation and one cellular which is necessary for the development of the inflammatory lesions in the thyroid gland. (auth)

12251 IMMUNOGENIC EFFICACY OF VARIOUS SYNGENEIC TUMOR CELL PREPARATIONS. Natale, Nicola; Reiner, Julius; Southam, Chester M. (Sloan-Kettering Inst. for Cancer Research, New York). Cancer; 28: No. 5, 1118-25(Nov 1971). (CONF-710529-2).

From twenty-fourth annual scientific session of the James Ewing Society; Portland, Oreg. (6 May 1971).

Experimental animals can be made resistant to implantation of syngeneic tumors and induction of tumors by viruses. In a few studies established tumors were inhibited by immunotherapy. Such results suggest that immunotherapeutic methods might be useful in clinical cancer. In animals, immunity is usually induced by living tumor cells or tumor-causing viruses. In man, a tumor vaccine must not expose the patient to risk of cancer implantation or cancer induction and must maintain its antigenicity. The immunogenic efficacy of various preparations which are potentially applicable to man was studied using methylcholanthrene-induced sarcomas in syngeneic C57BL/6 mice. As a positive control, transplantation immunity was induced by implanting live tumor cells and then excising the resulting tumors. This made mice resistant to 10 or 100 times the minimum number of tumor cells which produced tumors (MTD) in non-immunized controls, but did not protect against 1000 times the MTD. One million fresh gamma-irradiated tumor cells (10,000 rads ^{60}Co) were equally effective. Such cells are morphologically intact and metabolize for a limited time but do not propagate. After irradiation, cells could be stored at –70 C with only partial loss of immunogenicity, but if stored at –20 C they were ineffective. Tumor cells irradiated to a dose of 100,000 rads were also effective, but less so than the 10,000 rads preparation. Lesser but significant protection was effected by implanting Millipore chambers containing living tumor cells. This chamber prevents egress of the tumor cells, but apparently it does allow the tumor-specific transplantation antigens (TSTA) to reach the immunologically reactive hosts cells in an effective condition and amount. (auth)

Ecology

Refer also to abstracts 11996, 11997, 12029, 12275–12277, 12287, 12288, 12331, 12436, and 14507.

12252 (BNWL-1550(Pt.1), pp 103-6) FINE STRUCTURAL EFFECTS OF TEMPERATURE IN FISH. Hampton, J. C.; Adee, R. R. (Battelle Pacific Northwest Labs., Richland, Wash.).

Studies on effects of increased temperature on rainbow trout represent part of a program for future power development planning. It is important to gain knowledge of limits to which river water temperature can be raised and still permit sound management of the environment and maximum use of natural resources. Histological changes in fish exposed to a temperature of 30°C are described and illustrated. (H.L.W.)

12253 (CEA-N-1488) CONCENTRATION FACTORS FOR ^{137}Cs, ^{144}Ce, AND ^{106}Ru IN SEVERAL SPECIES OF EDIBLE MARINE MOLLUSKS AND CRUSTACEANS. Le Gall, Pierre; Ancellin, Jacques (Commissariat a l'Energie Atomique, la Hague (France)). Nov 1971. 17p. (In French). Dep. NTIS (U. S. Sales Only).

Several species of edible marine molluscs and crustaceans (Mytilus edulis, Gryphaea angulata, Venus verrucosa, Portunus puber, Cancer pagurus and Homarus vulgaris) were contaminated with various fission products: ^{144}Ce, ^{137}Cs, ^{106}Ru. The concentration factors obtained for mollusc flesh ranged from 100 to 300 for ^{144}Ce and from 4 to 10 for ^{137}Cs. Crustacea flesh was almost uncontaminated by ^{106}Ru although some contamination of the shell was observed. (France)

12254 (UCRL-73416) INSTRUMENTATION FOR A RADIOECOLOGICAL STUDY OF THE HUMBOLDT BAY MARINE ENVIRONMENT. Holladay, G.; Phelps, P. L.; Heft, R. E.; Harrison, F. L. (California Univ., Livermore. Lawrence Radiation Lab.). 16 Nov 1971. 11p. (CONF-711111-22). Dep. NTIS.

From Nuclear science symposium; San Francisco, Calif. (3 Nov 1971).

Field sampling operations and instruments used in a study of radioisotope transport through an aquatic ecosystem following release in reactor effluent are described. Methods and equipment used to collect water samples, bottom sediment samples, core samples, and samples of aquatic animals and plants are described. Instruments used to measure solar illuminance, temperature, and radioactivity of flowing water are listed. (C.H.)

12255 METODY RADIOEKOLOGICHESKIKH ISSLEDOVANII. (Methods of Radioecological Investigation). Verkhovskoi, I. N. (ed.). Moscow; Atomizdat (1971). 260p.

This book is a collection of 37 separate articles on laboratory and field studies in radioecology. Measurements of the content, distribution, and migration of specific natural and artificial radioisotopes are described. Radioactive Sr, Ce, and Cs in soils, ^{210}Po in the human organism, the content of ^{40}K and ^{137}Cs in laboratory animals, and the movement of radioisotopes through the lichen–reindeer–man food chain are examples of the subjects covered by a portion of the text. Other topics included are: the accumulation of U, Th, and Ra in fresh water plants, ultra-small quantities of U and Th in natural waters, and equipment for rapid measurement of radioactive contamination of surfaces by β- and γ-emitters under field conditions. (K.S.W.)

12256 TRANSFER OF RADIOCESIUM FROM LICHEN TO REINDEER. Holleman, D. F.; Luick, J. R. (Univ. of Alaska, College); Whicker, F. W. Health Phys.; 21: No. 5, 657-66 (Nov 1971).

An empirical two compartment model is presented that describes the transfer of radiocesium from fallout contaminated lichen to reindeer. Kinetic parameters were calculated from data derived from retention studies following a single dose of ^{134}Cs to reindeer maintained on a natural mountain tundra pasture at Cantwell, Alaska. Cesium retention values were statistically indistinguishable for the autumn and winter period, however cesium retention half-times were reduced 2 to 4 fold during the summer months as compared to the autumn–winter studies. Cesium kinetics in the reindeer were not influenced significantly by animal sex although a significant increase in cesium retention with animal weight was observed. Results obtained from controlled lichen feeding experiments indicated that about 20 to 30% of the radiocesium contaminating lichen is available for absorption by the reindeer. The model was tested by comparing predicted values with results obtained with a single reindeer maintained on a constant ^{134}Cs intake. Predicted values are compared to observed radiocesium concentrations in the lichen-caribou segment of the Arctic food chain. (auth)

Genetics and Cytogenetics

Refer also to abstract 12566.

12257 (ORNL-4740) BIOLOGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1971. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 157p. Dep. NTIS.

Very brief summaries of 321 projects in the areas of biochemistry, biophysics and cell physiology, genetics and developmental biology, mammalian genetics, pathology and immunology, and carcinogenesis are presented. (D.D.D.)

12258 GOLDEN COTYLEDON: A RADIATION-INDUCED MUTANT IN CUCUMBER. Whelan, Ernest D. P. (Canada Dept. of Agriculture, Morden, Manitoba). HortScience; 6: No. 4, 343-4(Aug 1971).

Golden cotyledon, in cucumber (Cucumis sativus L.), induced in seed treated with gamma radiation, is controlled by a single recessive gene, designated gc. The gene is lethal in the homozygous recessive state and seedlings die 7 to 10 days after emergence. (auth)

12259 RECOVERY OF HAPLOID YEAST SACCHAROMYCES CEREVISIAE FROM DOMINANT LETHALS INDUCED BY IONIZING RADIATION. I. INFLUENCE OF DOSE FRACTIONATION AND POSTIRRADIATION INCUBATION OF HAPLOID CELLS IN WATER ON ZYGOTE SURVIVAL. Vdovichenko, T. A. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika; 7: No. 11, 107-11(Nov 1971). (In Russian).

Recovery of haploid yeast from x-ray induced dominant lethals was under investigation. Survival of zygotes obtained from copulation of exposed cells and normal ones but not survival of haploid cells themselves was recorded. In this case zygote inactivation is induced by dominant lethals. It is shown that there is no recovery of haploid cells from dominant lethals in water. There is also no recovery from sublethal damage at dose fractionation. Also it is shown that irradiation does not affect the cell mating. (auth)

12260 STUDY OF THE RATE OF SPONTANEOUS MUTATIONAL PROCESS IN X-RAY SENSITIVE MUTANTS OF SACCHAROMYCES CEREVISIAE. Suslova, N. G.; Zakharov, I. A. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika; 7: No. 11, 91-8(Nov 1971). (In Russian).

The influence of mutations to x-ray sensitivity on the rate of spontaneous reversions to adenine and uracil requirement was studied in Saccharomyces cerevisiae. All five loci of x-ray sensitivity studied seemed to increase the frequency of the appearence of secondary colonies in adenine requiring strains, the most effective being the influence of the xrs_1. The rate of spontaneous mutagenesis was registered by two methods: on solid medium and in liquid. In both cases, the mutation xrs_{1-5} increased the frequency of spontaneous reversions to adenine non-requirement. Besides that, this mutation increased the spontaneous reversion to uracil non-requirement thus revealing the mutator effect. Four independent allelic mutations to x-ray sensitivity (xrs_{1-5}; xrs_{1-6}; xrs_{1-12}; xrs_{1-11}) increased the rate of spontaneous mutagenesis in approximately equal degree. These results are indicative of the mutator effect of the radiosensitivity of locus xrs_1. (auth)

12261 MUTAGENIC EFFECT OF X-RAYS ON MICE PRONUCLEI. Fazylov, U. T.; Pomerantseva, M. D. (Inst. of General Genetics, Moscow). Genetika; 7: No. 11, 64-9(Nov 1971). (In Russian).

Acute x irradiation (100R) was administered to pregnant mouse females at 11:00 a.m. on the day of the copulation plug. The yield of reciprocal translocations was used as criterion of the radiosensitivity of the pronuclei, 4 males of 51 (7.8%) developed from the irradiated zygotes were heterozygous for reciprocal translocations. It made 3.9% per pronucleus. One male was heterozygous for a translocation between the X-chromosome and an autosome. Comparision with the literature data showed that genetic radiosensitivity of the pronuclei at the criterion used was close to that of the late spermatids.

12262 KHROMOSOMY CHELOVEKA I OBLUCHENIE. (Human Chromosomes and Radiation). Bochkov, N. P. Moscow; Atomizdat (1971). 168p.

The cytogenetic effects of ionizing radiation in the embryonic and somatic cells of man are systematized in this monograph. Techniques for studying radiation-induced chromosomal damage, and the relation between radiation and chromosomal damage are discussed. Chromosomal aberrations as a function of radiation dose (frequency and size) are dealt with both in vivo and in vitro. The last chapter is devoted to a quantitative evaluation of the effects of radiation on human chromosomes. 595 references. (K.S.W.)

12263 MIXED EFFECT OF GAMMA RADIATIONS AND ULTRASOUNDS ON DRY AND WATER-SATURATED FAGOPYRUM ESCULATUM MOENCH SEEDS. Zolyneak, C. C. An. Stiint. Univ. Al. I. Cuza Iasi, Sect. 2a; 16: No. 1, 53-8(1970). (In Rumanian).

As in the case of complex treatments involving radiations and magnetic fields, in the present case, combined gamma radiation and ultrasound treatments, the interference phenomenon between the radiobiological and sonobiological processes appears subsequently to the treatment. This phenomenon may have a stimulating or inhibiting effect on the growth test, or may enhance or reduce the percentage of chromosomal aberrations, according to the sequence observed in the treatment. As a result it was found that complex treatments with gamma radiations, followed by ultrasounds, result in cancelling the radiobiological effects induced by gamma radiations and the occurrence of a stimulated root and hypocotyl growth, and this was more manifest when the test was run at a greater interval (15 days later). In the cytogenetic test, this phenomenon is not evident, although the percentage of chromosal aberrations is rather high. These results prove that the radio- and sonobiological processes last longer, that their interference or overlapping in a certain sequence, that could account for the stimulation or inhibition phenomena of root growth and hypocotyl length, are of a cytoplasmatic nature and depend on their sequence. The fact that these processes can overlap or interfere, and that the changes that appear in the structure, physiology, and biochemistry of the cytoplasm can result in stimulations or inhibitions of the growth, shows that as a result of these combined treatments remarkable growth inhibitions may occur, supplemented by insignificant chromosomal disturbances and conversely, a high percentage of aberrations is followed by marked growth stimulation. It is considered that the method of complex treatments with ionizing radiations and ultrasounds may be a particularly efficient way of plant improvement by the radiomutagenic process. (Rom. Sci. Abstr.)

12264 BEAN MUTANT INDUCED BY IONIZING RADIATION. VI. UNIFOLIATE MUTANT. Moh, C. C.; Alan, J. J. (Inter-american Inst. of Agricultural Sciences, Turrialba, Costa Rica). Turrialba; 21: No. 2, 231-2(Apr-Jun 1971).

Dry seeds of a bean variety, "Mexico 80 R", were irradiated with an acute dose of gamma radiation from a Cesium-137 source. The dose rate was 945 R per min. Four hundred seeds were irradiated with 8 kR and after irradiation the seeds were grown in the field at Turrialba. A total of 246 R_1 plants were harvested and the R_2 and R_3 progenies were grown in the greenhouse for mutation studies. The unifoliate mutant was found in the R_3 progeny test. (auth)

12265 GAMMA IRRADIATION OF POT MUM SEEDLINGS AND ITS BREEDING EFFECT. II. Matsubara, Hisao (Tokyo Metropolitan Isotope Research Center); Hashimoto, Sadao. Nogyo Oyobi Engei; 46: No. 4, 651-4(Apr 1971). (In Japanese).

For investigating the influence of γ irradiation on potted mum seedlings, height of plants, type of leaves, and color of flowers are important points to be studied. Color of flowers was investigated here as it is rather easy to approach. Though many mutations occurred in pink original plants, and many mutated colors were found, a definite tendency could not be seen. Occurrence ratio of mutation was high in plants grown from cut sprouts of the top of original plants, but most of the mutation appeared partly, while complete mutation was obtained mostly from cut sprouts of the lower part of stock plants. The ratio of mutation was low in plants whose flowers bloom later, and partly mutated flowers decreased in such plants, while completely mutated flowers were apt to increase. In order to isolate and fix these mutated plants and prevent disappearance of the mutation, petals of the mutated flowers were removed, and only calyxes were left. Mutated plants were obtained when pieces of the above calyxes were cultivated with separate culture in test tubes and planted in sterilized peat moss pots. (Japan)

12266 GAMMA IRRADIATION OF POT MUM SEEDLINGS AND ITS BREEDING EFFECT. I. Matsubara, Hisao (Tokyo Metropolitan Isotope Research Center); Hashimoto, Sadao. Nogyo Oyobi Engei; 46: No. 3, 515-18(Mar 1971). (In Japanese).

Many cases were reported concerning the γ and x irradiation of chrysanthemums to cause mutation and to obtain mutated plants. It is believed that those mutations are due to the mutation of chromosomes. Height of plants was slightly reduced by irradiation, and the plants were withered by too strong irradiation. The fatal dose of γ rays is presumed to be more than 5 KR. Results of investigations from various points showed that the effective x-ray dose to bring about mutation on chrysanthemums is a dose rate of 85 to 95 R/min and a dose of 1,200 to 3,000 R. In the case of γ rays, radical radiosensitivity varies according to the kind of plant, but is generally less than 50% of the fatal dose. On investigations made on roses, it was reported that more new breeds appeared at a dose rate of 800 R/day than at a dose rate of 80 R/day in the case of 8 KR irradiation. On potted mum, only a few cases were reported, so that the dose and dose rate must be decided after further investigation. (Japan)

12267 SOMATIC CROSSING-OVER IN THE HOUSEFLY. Noethiger, R.; Duebendorfer, A. (Univ., Zurich). Mol. Gen. Genet.; 112: No. 1, 9-13(1971).

X-rays were found to produce genetically marked cells and cell clones in heterozygous larvae of Musca domestica. The results favor the conclusion that these marked clones originated by somatic crossing-over. The technique should prove useful in developmental analyses of the housefly. (auth)

12268 CORRELATION BETWEEN SENSITIZATION TO GAMMA-RAYS BY PURINE STARVATION AND THE REC GENES IN ESCHERICHIA COLI K-12. Baptist, Jeremy E.; Starkey, Frank M.; Friesen, Benjamin S.; Scudiero, Dominic A. (Univ. of Kansas, Lawrence). Mol. Gen. Genet.; 112: No. 1, 36-42 (1971).

After purine starvation the recombination proficient (Rec^+) strains of E. coli K-12 tested were sensitized to inactivation by gamma-rays. No such change was noted in the Rec^- strains tested. These results suggest that purine starvation may sensitize cells to ionizing radiation by inhibiting repair controlled by the recA, recB, and recC genes. (auth)

12269 INFLUENCE OF GROWTH PHASE ON UV INDUCED LETHALITY AND DNA BREAKDOWN IN A KORNBERG POLYMERASE DEFICIENT resA STRAIN OF ESCHERICHIA COLI. Green, M. H. L.; Gray, W. J. H.; Murden, D. J.; Bridges, B. A. (Univ. of Sussex, Brighton, Eng.). Mol. Gen. Genet.; 112: No. 2, 110-16(1971).

A stationary phase culture of the Kornberg polymerase deficient resA strain R15 was more sensitive to uv irradiation than a growing culture. The dose reduction factor was 2 to 2.5. Uv induced DNA breakdown was also greater in a stationary culture than in a growing culture. The relationship between lethality and DNA breakdown was not quantitative. On the basis of these results we suggest that in this DNA polymerase deficient mutant the repolymerisation step of excision repair may take place at or after DNA replication. Survival and DNA breakdown after uv would then depend in a complex way on the resultant of the rates of excision, nuclease activity and DNA replication. (auth)

12270 EFFECT OF CHRONIC EXPOSURE OF ^{60}Co ON THE FREQUENCY OF METAPHASE CHROMOSOME ABERRATIONS IN THE LIVER CELLS OF THE CHINESE HAMSTER (IN VIVO). Brooks, A. L.; Mead, D. K.; Peters, R. F. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Int. J. Radiat. Biol.; 20: No. 6, 599-604(1971).

Chinese hamsters were exposed for 6, 15, and 42 days to dose-rates of 154, 95, 44, or 14 rads/day of ^{60}Co gamma irradiation. All animals exposed to 154 or 95 rads/day died before the 42nd day. The chromosome aberrations scored in the liver cells are tabulated and the frequency of aberration per cell in metaphase chromosomes is plotted against cumulative dose. The rings plus dicentrics per cell were related to total radiation dose. The results indicated a marked dose-rate effect when very high dose-rates were compared with low dose-rates for single acute exposures, but protraction of the dose from 6 to 42 days or changing dose-rates from 154 to 14 rads/day had little effect on the total aberration frequency % of abnormal cells or isochromatid deletions. (UK)

12271 INFLUENCE OF HYPOTONIC TREATMENT ON CHROMOSOME ABERRATIONS INDUCED IN HUMAN BONE-MARROW CELLS BY GAMMA RAYS. Pyatkin, E. K.; Suskov, I. I.; Petrova, S. A. (Inst. of Biophysics, Moscow). Lancet; 1: No. 7741, 100(8 Jan 1972).

Bone marrow was collected from patients with malignant tumors of thoracic or pelvic organs, who had been exposed to 100, 200, and 300 rads of ^{60}Co γ radiation (dose-rate 88 rad/min). Results are presented in tabular form. With all doses, considerably more aberrant metaphases, chromatid-type aberrations (chromatid fragments and exchanges), and paired fragments were demonstrated after treatment with potassium chloride (0.5% solution), than with a mixture of Hanks' solution and distilled water (1/3). There were no real differences between the frequencies of clearly identified aberrations (dicentrics and rings). The need for unification of methods is pointed out. (UK)

12272 IN VITRO AND IN VIVO SENSITIVITY OF CULTURED BLOOD LYMPHOCYTES TO RADIATION INDUCTION OF CHROMOSOME ABERRATIONS. Clememger, J. F.; Scott, D. (Medical Research Council, Harwell, Eng.). Nature (London) New Biol.; 234: No 48, 154(1 Dec 1971).

The yield of dicentrics/cell from rabbit blood γ irradiated in vitro and in vivo (whole body irradiation) was compared over a range of doses from 288 to 588 rads. The frequency of dicentrics after in vitro irradiation averaged 5% less than blood of the same animal in vivo. Similar observations on human subjects receiving 30 to 50 rads of whole body irradiation were variable. (UK)

Health Physics and Safety

Refer also to abstracts 12107, 12180, and 14081.

12273 OXIDE FUME FORMED BY THE COMBUSTION OF PLUTONIUM AND URANIUM. Carter, R. F.; Stewart, K. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 819-37 of Inhaled Particles III. Vols. I and II. /Walton, W. H. (ed.). Old Woking, Eng.; Unwin Brothers Ltd. (1971).

From third international symposium on inhaled particles; London, England (14 Sep 1970).

Particulates formed by the ignition of plutonium and uranium metals in air may contain significant fractions which are potentially respirable. Accident situations such as metal fires, explosive dispersal, or vapour emission represent extreme forms of release, and part of the aerosol may consist of a fume, formed by condensation of vapour. Laboratory experiments with burning metal droplets and exploding wires showed that the aerosol fraction, consisting of particles smaller than 1 μm, is essentially a fume which disintegrates in liquids to give components in the range 10 to 1000 nm. Mixed sodium–plutonium aerosols have an apparent solubility in water which is related to the atomic ratio of the two elements and is roughly constant for Na/Pu > 1. The presence of inert particles during aerosol formation reduces the respirable material by a factor of up to about 5. Partial fractionation of the americium (^{241}Am, the daughter of ^{241}Pu) occurred in the fume emitted by burning droplets such that the respirable particulate showed an enhancement by a factor of about 4 compared to the parent metal. (auth)

Radioactive Contamination and Decontamination

Refer also to abstracts 12020 and 12253.

12274 (BNWL–1550(Pt.1), pp 95-102) REMOVAL OF INTERNAL EMITTERS. (Battelle Pacific Northwest Labs., Richland, Wash.).

Methods were developed to hasten the removal, prevent the deposition, or decrease the damage potential from ingested or absorbed radionuclides. Studies were also conducted on absorption and tissue distribution of radionuclides to help in understanding and predicting their behavior and to serve as a basis for recommendations for the treatment of exposed persons. Rats were given various levels of Ca- or Zn-DTPA one hr after intravenous administration of plutonium citrate. Maximum removal from bone was achieved at treatment levels as low as 0.01 mmol/kg; however, higher dose levels were more effective in removing plutonium from the liver. Other experiments were conducted to compare the effectiveness of DTPA for removal of ^{238}Pu, ^{65}Zn, and ^{144}Ce from the liver and bone of rats. (H.L.W.)

12275 (NP–19133) ANNUAL REPORT OF THE EASTERN ENVIRONMENTAL RADIATION LABORATORY, JANUARY–DECEMBER 1970. (Eastern Environmental Radiation Lab., Montgomery, Ala.). Oct 1971. 71p. (EERL–71-4). NTIS.

The role of the Eastern Environmental Radiation Laboratory in a national program for measuring the population exposure to ionizing and nonionizing radiations and for assessing the radiological quality of the environment is discussed. Activities during 1970 are summarized. A list is included of 12 publications during the period that report the results of studies carried out. (C.H.)

12276 (NRL-F–45) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND. Quarterly Report, April–June 1971 and Pacific Area Monitoring, 4 June–31 August 1971. (National Radiation Lab., Christchurch (New Zealand)). 28p. Dep. NTIS (U. S. Sales Only).

The results of routine monitoring of radioactive fallout in New Zealand during the second quarter 1971 are presented. Extended monitoring operations during the French nuclear tests in the South Pacific started on 4 June and results are given for all samples measured up to the end of August. The location of collecting and monitoring stations and a quarterly comparison of the results of routine measurements are included. (C.H.)

12277 (RISO–247) ENVIRONMENTAL RADIOACTIVITY IN GREENLAND IN 1970. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe, Research Establishment). Jul 1971. 18p. Dep. NTIS (U. S. Sales Only).

Measurements of fall-out radioactivity in Greenland in 1970 are reported. Strontium-90 (and ^{137}Cs in most instances) was determined in samples of precipitation, sea water, vegetation, animals, and drinking water. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in Greenland in 1970 are given. (auth) (Denmark)

12278 CONTAMINATION OF A UNIVERSITY PRINT SHOP RESULTING FROM THE CLEANING OF A STATIC ELIMINATOR DEVICE. Caruthers, L. T.; Maxwell, R. B. (North Carolina State Univ., Raleigh). Health Phys.; 21: No. 5, 713-14(Nov 1971).

Following cleaning a bar type static eliminator, incorporating 57 mCi of ^{210}Po in the form of ceramic microspheres, with organic solvent a significant leakage of radioactive material occurred. The degree of contamination of plant and personnel and the subsequent decontamination are considered. The radiation hazards involved and the possible reevaluation of the conditions for commercialization of such devices are considered. (UK)

12279 RADIOACTIVE CONTAMINATION OF THE SKIN. Schofield, G. B. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). J. Soc. Cosmet. Chem.; 22: 535-45(1971).

Contamination of the human skin by radioactive materials is a comparatively new hazard, associated primarily with the nuclear fuel reprocessing industry and the operation of nuclear power stations. The main hazard to the skin arises from β emitting radionuclides, and the effect on the skin of these radiations and others, is discussed. The various methods available for removing contaminated material from the skin are described, and the general surveillance and care of the skin of atomic energy workers is also considered. (auth)

12280 DIFFICULTIES IN MEASURING THE MAXIMUM PERMISSIBLE LEVELS OF SURFACE CONTAMINATION FOR RADIONUCLIDES THAT DECAY PRIMARILY BY ELECTRON CAPTURE. Bush, D.; Hundal, R. C. (Univ. of Birmingham, Eng.). Health Phys.; 21: No. 5, 651-5(Nov 1971).

The responses of a number of detectors commonly used for surface contamination monitoring were examined for radionuclides that decay primarily by electron capture. Count rates obtained with the detectors close to surfaces contaminated to a level of 10^{-4} μCi/cm^2 are reported for the electron capture radionuclides ^{51}Cr, ^{54}Mn, ^{65}Zn and ^{125}I. The results show that many detectors in common use cannot detect such a level of surface contamination of these radionuclides in the presence of quite a low background. In view of these practical difficulties, the basis of the derivation of the maximum permissible levels of surface contamination currently specified in UK legislation and Codes of Practice was examined. For electron capture radionuclides such as those listed above, it is proposed that the maximum permissible levels of surface contamination should be relaxed by a factor of 10, or alternatively that such maximum permissible levels should be specified in terms of dose rate, particularly where external radiation represents the limiting hazard. (auth)

12281 RETENTION OF 1 TO 44 μ SIMULATED FALLOUT PARTICLES BY SOYBEAN AND SORGHUM PLANTS. Witherspoon, John P.; Taylor, F. G. Jr. (Oak Ridge National Lab., Tenn.). Health Phys.; 21: No. 5, 673-7(Nov 1971).

Six-week-old soybean and sorghum plants were contaminated in the field with a siliceous fallout simulant containing ^{134}Cs. Initial fallout interception and retention of particles by whole plants and plant parts were determined for a 5 week period. Initial interception of particles was similar with values of 39.5 and 38.2% of the deposition quantity retained by soybeans and sorghum, respectively. Sites of initial interception, however, differed between species. Weathering half-lives for particles were determined for different plant parts and for two time components (0 to 7 and 7 to 34 days following deposition). Half-life values were similar for the 0 to 7 day component, but differences between species and plant parts were found for the 7 to 34 day component. (auth)

12282 ARTIFICIAL RADIOACTIVITY OF SOME HYDROBIONTS IN THE SOUTHERN OCEAN. Tkachenko, V. N.; Patin, S. A. (All-Union Scientific-Research Inst. of Marine Pisciculture, and Oceanography, Moscow). Okeanologiya; 11: No. 4, 705-10(Jul-Aug 1971). (In Russian).

Artificial radionuclides were determined by the gamma-spectrometric technique in some hydrobionts taken from the Antarctic sector of the Atlantic Ocean (Scotia Sea) in January through March of 1967 and 1968. Zirconium-95–niobium-95, ruthenium-106–rhodium-106, and cesium-137 were identified and determined quantitatively in a number of samples mainly in the Antarctic krill. The radionuclides discovered are apparently of the atmospheric origin and are products of atomic explosions. The ac-

cumulation of noticeable amounts of fission products in krill makes it possible to use the latter as a hydrobiont-indicator when the above-mentioned gamma emitters are found in the Antarctic photic layer. (auth)

12283 DERIVED WORKING LIMITS FOR β/γ SURFACE CONTAMINATION INCLUDING LOW ENERGY β EMITTERS. Wasson, M. M. (Central Electricity Generating Board, Essex, Eng.). pp 248-55 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The derived working limits (DWL) for β/γ surface contamination at present in use in relation to the actual hazard represented by various contaminants at these levels are considered. They prevent the basic dose limits of ICRP from being exceeded. It is concluded that, particularly for low energy β emitters, the levels are unrealistically high and a system of derived working limits which takes into account the energy of the contaminant is proposed. Possible dangers present in some methods of monitoring for β/γ surface contamination, based on the assumptions used to calculate DWL's in the past, are also considered and a method which overcomes these dangers is described. (France)

12284 LUNG CANCER AMONG POPULATIONS HAVING LUNG IRRADIATION. Axelson, O.; Rehn, M. (Regional Hospital, Oerobro, Sweden). Lancet; 1: No. 7740, 46-7(1 Jan 1972).

A brief reply is made to criticisms by Archer [Lancet, p 1261 (Dec 4)] of an earlier paper. The Swedish approximation from 100 p Ci per liter of radon daughters to 1 W.L. is mentioned in relation to measurements in more or less well-ventilated mines and to the probable underestimation of radon daughter levels. (UK)

12285 PREDICTIVE MODEL FOR RADIOCESIUM INTAKE FROM MILK: ERRORS ASSOCIATED WITH AMONG-COW VARIATION. Lengemann, F. W.; Wentworth, R. A. (New York State Veterinary Coll., Ithaca). Contract AT(30-1)-2147. Health Phys.; 22: No. 2, 135-41(Feb 1972).

Data from 18 cows were used to evaluate variations in the milk secretion curves as a source of error when estimating the projected intake of radiocesium from milk by humans after pasture contamination. These data indicated that the transfer function for radiocesium into milk is very similar among cows with a percentage relative standard error of about 10% for the 1st day and 1% or less by the 10th day. Using these data a prediction model based on the ratio of the total amount secreted into milk over time to the amount in milk on any particular day was tested. Variations were made in the values of deposition half-time and pasture loss half-time to determine how these could affect the intake prediction. The calculations showed the cow contribution to the total deviation from the assumed true value of the projected intake to be 40% at most. The deviation from the true intake value was ±68% on day 1 and ±35% at day 7 when the deposition half-time was 4, 5, or 6 days and the pasture loss half-time ranged from 12 to 18 days. (auth) (UK)

12286 REMOVAL OF RADON AND THORON DAUGHTER PRODUCTS FROM GLASS FIBRE AIR SAMPLE FILTERS. Stephenson, J.; Stevens, D. C.; Morton, D. S. (Atomic Energy Research Establishment, Harwell, Eng.). Ann. Occup. Hyg.: 14: No. 4, 309-19(Dec 1971).

Naturally occurring radon and thoron daughter products in the atmosphere are collected with atmospheric dust on air sample filters and prevent immediate estimation of any long-lived radioactive nuclide of high toxicity that may also be present. A period of up to 48 hr may be necessary to allow the natural activity to decay. A method is described for the removal of most of the natural activity from the filter within a few minutes, by passing air carrying a chlorinating agent through the filter which is heated to about 500°C in a small furnace. Radioisotopes of bismuth and lead, which are responsible for the bulk of the natural α and β activity, are converted to their chlorides; these are volatilized and carried away in the gas stream. Between 80 and 95% of the natural α and β activity is removed giving a considerable reduction in the uncertainty in estimation of long-lived nuclides. (auth) (UK)

12287 AIR SAMPLING AS PART OF AN INTEGRATED PROGRAMME OF MONITORING OF THE WORKER AND HIS ENVIRONMENT. Langmead, W. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 983-94 of Inhaled Particles III. Vols. I and II. /Walton, W. H. (ed.). Old Woking, Eng.; Unwin Brothers Ltd. (1971).

From third international symposium on inhaled particles; London, England (14 Sep 1970).

The general principles of monitoring of the worker and his environment are discussed in relation to work with uncontained radioactivity with particular reference to the control of air contamination hazards. The methods of using static samplers and personal air samplers for monitoring the work-place are described, and the interpretation of the results in terms of the basic standards of MPC_a to confirm that operating conditions are satisfactory is discussed. The place of particle-size measurements in air sampling is also reviewed. Proposals for the assessment of working areas at three alternative levels of risk are presented as part of an integrated programme of control of radioactive contamination. (auth)

12288 RADIOACTIVE CONTAMINATION OF BONE. Toettermann, L. (Univ. of Helsinki); Kiviniitty, K.; Sokkanen, R. Health Phys.; 22: No. 2, 193-5(Feb 1972).

Fifty three human fetal femoral bone specimens collected in Lapland from 1962 to 1966 were compared for radioactivity with a group obtained in 1967 from Southern Finland. Liquid scintillation counting was used and did not distinguish between activity from ^{137}Cs and ^{90}Sr. The average counting time was 300 min. The results did not corroborate the assumption that human fetal bone is exposed to a greater nuclide contamination hazard in the north of Finland than in the south. (UK)

Dosimetry and Monitoring

Refer also to abstracts 12216, 12220, 12396, 12510, 12544, and 14508.

12289 COMPARATIVE STUDY OF ^{137}Cs γ RADIATION AND ULTRAVIOLET RADIATIONS. MEASUREMENT OF THE DOSE ABSORBED BY HUMAN BLOOD TISSUE AS A FUNCTION OF HEMATOCRIT. Pompidou, A.; Le Go, A.; Malarbet, J. L.; Le Go, R. (CEN, Fontenay-aux-Roses, France). Compt. Rend. Soc. Biol.; 164: No. 12, 2429-33(1970). (In French).

Biological dosimetry carried out in vitro on human blood with variable hematocrits shows the wide variations in the dose absorbed as a function of hematocrit. These variations occur inversely according to whether the irradiation is performed with an ultraviolet source (not very penetrating) or with highly penetrating radiation (cesium-137 γ radiation for example). This study should lead to a better measurement of the dose absorbed by a sample of human blood of given hematocrit. Accurate dosimetry is indeed essential before any treatment using extracorporeal blood irradiation in human pathology. (France)

12290 COMPARISON OF METHODS FOR DETERMINING HIGH γ-DOSE RATES. I. Pavlicsek, I.; Bod, L.; Horvath, Zs.; Veres, A. Izotoptechnika; 14: No. 6, 26-41(Jun 1971). (In Hungarian).

A comparison of methods using ionization chambers, calorimetry, chemical dosimetry, photoactivation, and Si semiconductor detectors, applied at the high activity gamma-facility of the Institute of Isotopes of the Hungarian Academy of Sciences is presented. (auth)

12291 DOSIMETRY OF ^{129}Cs AND ^{131}Cs. Anger, R. T. (Cincinnati General Hospital). Phys. Med. Biol.; 16: No. 4, 698-70(Oct 1971).

The absorbed doses from 1 millicurie of ^{129}Cs to the total body and specific organs were compared with those from ^{131}Cs. Estimates were based on rat distribution data and human total body retention data. Organs examined were the kidneys, bones, liver, testes, lungs, pancreas, spleen, brain and heart. Except for the dose to the total body, the calculated doses from ^{129}Cs were consistently less than those from ^{131}Cs. (UK)

12292 DIETARY INTAKES OF IODINE AND THYROID DOSIMETRY. Dolphin, G. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys.; 21: No. 5, 711-12 (Nov 1971).

The required daily uptake by the thyroid is between 40 and 100 μg/day. The percentage uptake of iodine, U, by the thyroid is related to the dietary intake, Dμg/day, for a constant daily thyroid requirement of 70 μg by the relationship $70 = U \times D/100$. The daily dietary intake in the USA and UK is examined. The thyroid competes with the kidney for available iodine and when this is low the thyroid avidity for iodine and thus the mass of the thyroid increases. Thyroid masses reported in different districts are considered. The radiation dose to the thyroid from incorporated radioiodine is proportional to U/M. From the discussion, it is clear that the two parameters U and M are not independent and both vary with dietary intake increasing with low intakes and decreasing with high intakes. It is therefore important to select both parameters

appropriate to the dietary intake of the country or region in which the people live when dose calculations are being made. (UK)

12293 NEUTRON DOSIMETRY WITH NUCLEAR TRACK DETECTORS APPLIED TO IN VIVO NEUTRON ACTIVATION ANALYSIS. Agard, E. T.; Jervis, R. E.; McNeill, K. G. (Univ. of Toronto). Health Phys.; 21: No. 5, 625-9(Nov 1971).

The registration in 10 μm Makrofol G plastic of fission track holes from foils of ^{232}Th and natural uranium is used for monitoring of fast and thermal neutrons during in vivo neutron activation procedures. The holes are enhanced by NaOH etching and counted by an electrical sparking method developed by Cross and Tommasino [Radiat. Effects 5: 85(1970)]. This method uses aluminized Mylar as one electrode, from which the aluminum is evaporated at the site and time of the spark. By operating within the range of linearity of the system, the fast neutron doses can be determined from ^{232}Th foil data and the thermal fluences can be monitored by data from both foils. Good agreement was found between fast neutron doses measured by this method and those determined by a completely different system used in similar work at the Brookhaven National Laboratory. (auth)

12294 SIGNIFICANCE OF BORDER-LINE RAYS FOR RADIATION RESEARCH. PART 4. THE PHENOMENON OF THE BODY DOSE AND THE MESENCHYMA THEORY. Becker, Olga. Strahlentherapie; 142: No. 1, 52-63(Jul 1971). (In German).

In previous papers, two different fields of activity of the absorbed quantum energy to the cutaneous system within the totality were demonstrated; there was made a distinction between skin and body dose. The body dose shows a significant proportionality between skin reaction and irradiated body volume. Therefore, a uniform ubiquitous tissue substrate can be assumed, absorbing the quantum energy. Bipartizing the body tissues in a nonuniform, transitory tissue and a uniform, ubiquitous, mesenchymal permanent tissue, nothing but the latter can be quoted for the explanation of the proportionality. Previous experimental investigations lacking, we can only empirically substantiate through observations and experiences that the absorption of ionizing quantum energy in the mesenchyma forms an essential factor for the function of the mesenchyma and for the effect of the body dose on the skin. We came to the following findings: the mesenchyma is able to take up ionizing quantum energy from the environment and to utilize it to a certain amount for energy consuming biopositive holistic processes. A certain surplus of energy, not utilizable anymore, can be regulated within the totality. Only a further surplus of absorbed energy beyond a limiting value has a damaging and destructive effect, through the known processes, leading to a deposition of energy in structural elements. Yet, these findings empirically made have to be investigated. The long wave border-line rays at present yield the most practical method for quantitative measurements of the quantum energy absorbed by the superficial dermal layers. Thus they open a new way for investigation of the fate of absorbed ionizing quantum energy within the totality, scientifically more exact than hitherto. (auth)

12295 STANDARD METHOD OF CALCULATION IN EXTRACTING A CONCENTRATED RADON SOLUTION FOR THE PREPARATION OF RADON BATHS. Andreev, S. V. (Central Inst. of Health and Physiotherapy, Moscow). Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; 35: 454-8(Sep-Oct 1970). (In Russian).

The calculation of radon concentration in solutions made from radium preparations is time consuming. In order to simplify the calculations, a standardized procedure is adopted in which volumes of solution and loss coefficients are fixed. Then, very simple relations are obtained for the preparation of standard portions of radon solutions having a radon concentration of 100 Mache units. The volume of standard solution is directly proportional to the amount of radium on hand. The amounts of standard solutions are tabulated for preparation once and twice per week with a 5- and 6-day week for 30 mg of radium preparation in the extraction equipment. (TTT)

12296 PROBLEMS CONCERNING RADIOACTIVE CONTROL IN NONDESTRUCTIVE INSPECTION FACTORIES. Yoshizawa, Yasuo (Tokyo Univ.); Bessho, Yuko; Ono, Michizane. Genshiryoku Kogyo; 17: No. 5, 31-5(May 1971). (In Japanese).

Discussion is presented on the results of measurements on the exposure level of workers to radioactivity and the actual state of working places for non-destructive testing. The degree of exposure of workers to radioactivity may be larger than that indicated by film badges, because the direction of the radioactivity that arrives at the workers is not necessarily in the direction of the badges, and the workers do not always obey safety direction, for example, they take off the film badges when they are expected to work in places where the exposure seems to be large. Objects of this study were the workers who work with industrial x-ray instruments, radioactive isotopes, and accelerators such as van de Graaff, linear accelerator, and betatron. In an extreme case, a worker reported that he took up a γ-ray source of about 10 Ci with a bare hand. (Japan)

12297 ABOUT THE DETERMINATION OF FOCAL DOSES BY MEANS OF THE THERMOLUMINESCENCE-DOSIMETRY IN TELECOBALT IRRADIATION OF THE CARCINOMA OF THE URINARY BLADDER. Niklander, Seppo (Central Hospital, Kotka, Finland). Strahlentherapie; 142: No. 1, 64-7(Jul 1971). (In German).

The results of the determinations of intracavitary focal doses are presented in 15 patients with carcinoma of the urinary bladder. In 12 patients the measured value obtained by means of the thermoluminescence-dosimetry during telecobalt irradiation ranged between the calculated maximum and minimum dose. The greatest variation below the calculated minimum effective dose was 4%. (auth)

12298 METHODS CONCERNING THE DETERMINATION OF THE CORRECTION-FACTORS OF SCATTERED RADIATION IN THE STANDARD IONIZATION CHAMBERS OF X-RAY DOSIMETRY. Willuhn, K. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Strahlentherapie; 142: No. 1, 68-72(Jul 1971). (In German).

The author reports on two different experimental methods for determination of the correction-factors of scattered radiation in the standard ionization chambers of x-ray dosimetry. With the help of an equation, which was deduced from theoretical observations, a conversion of the results, maintained by using a particular chamber, can be employed also in chambers with different geometric dimensions. (auth)

12299 AUTOMATIC DOSIMETRY SYSTEM FOR ^{60}Co UNITS. Lorenz, Erhard; Mauderli, Walter (Univ. of Florida, Gainesville). Radiology; 101: No. 3, 679-82(Dec 1971).

An automatic dosimetry system for ^{60}Co γ units, requiring only the presetting of the desired given dose on a keyboard, is described. The system corrects for timing errors and decay in source strength. For a given source-to-skin distance the radiation output of the measuring system is correct for any field size combination. Therefore, exposure time tables are unnecessary, eliminating one major source of error and also saving time. (auth)

12300 DOSE TO THE ACTIVE BONE MARROW, GONADS, AND SKIN FROM ROENTGENOGRAPHY AND FLUOROSCOPY. Antoku, Shigetoshi; Russell, Walter J. (Atomic Bomb Casualty Commission, Hiroshima. Atomic Bomb Casualty Commission, Nagasaki). Radiology; 101: No. 3, 669-78(Dec 1971).

With use of phantom dosimetry, bone-marrow integral, gonadol, and skin doses were calculated for nearly all radiographic and fluoroscopic examinations. The data are included in tabular form for reference purposes. (auth)

12301 PROTECTION AGAINST LOW ENERGY OR SHORT RANGE RADIATIONS AND THE BIOLOGICAL EFFECTS OF RADIATION. 1st European Congress of the International Radiation Protection Association, Menton, France, October 9, 1968. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). 394p. (In several languages). (CONF-681013).

Separate abstracts were prepared for 36 of the 46 papers presented. The remaining 10 papers were previously included in NSA. For abstracts of these papers see a cumulative report number index under CONF-681013. (W.H.K.)

For abstracts of individual papers see: 12113–12115, 12136, 12165–12169, 12185, 12214–12216, 12283, 12302–12314, 12336, 12432, 12483, 12484, 12552, 13382–13384, and 14451.

12302 SOME TECHNIQUES FOR THE MEASUREMENT OF TRITIUM. Gibson, J. A. B.; Burt, A. K. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 37-44 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The low beta-ray energy (18 keV maximum) and the diversity of chemical forms which pose many problems in the measurement of tritium are discussed. Tritiated water (HTO) in air is measured by passing the air through a flow ionization chamber or by ex-

tracting the water vapor from the air. The ionization chamber which may be compensated for the effects of external gamma radiation has a limit of detection of about 5 μCi m^{-3}. Condensed water vapor is measured continuously in a flow cell filled with anthracene crystals and the limit of detection is 0.1 μCi m^{-3} (0.02 mpc$_a$). Samples of the water are also measured in a liquid scintillation counter which gives a lower limit of 10^{-3} μCi m^{-3}. The liquid scintillation counter is also used for the analysis of urine samples. The limit of detection in this system is about 30 pCi g^{-1}. Tritium gas (HT or T$_2$) is evolved from tritium targets in particle accelerators and from tritiated strips used as electrostatic eliminators. The techniques used to determine the surface activity are described. Finally some tritiated organic compounds are particularly hazardous because they are incorporated into the body in a selective manner. The sensitivity of many detection systems is inadequate for the control of these materials. (France)

12303 RELEASE OF TRITIUM FROM RADIOACTIVE LUMINESCENT COLORANTS. Lorenzen, K.; Born, H. J. (Technische Hochschule, Munich). pp 45-50 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France: Service Central de Protection Contre les Rayonnements Ionisants (1971). (In German).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Equipment for detecting tritium released from luminescent colorants in powdered samples or paints is described. The different activities were determined and recorded. The average activity released per day by the tritium represents 0.06 per cent of the activity incorporated. (France)

12304 DOSIMETRY AND PROTECTION PROBLEMS IN THE MANUFACTURE OF FUELS CONTAINING HIGH IRRADIATION PLUTONIUM. Preston, H. E.; Fraser, D. C. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). pp 74-8 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France: Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

In the fabrication of experimental fuel elements containing plutonium oxide large quantities of bare fuel materials are handled. The fuels vary widely in isotopic content and age after separation, and may be mixed with uranium and/or graphite, in varying proportions. The lithium fluoride dosimeter was used to measure routine extremity doses to personnel working in standard glove boxes, while film badges were used to monitor their whole body dose. The limiting hazard was soon seen to be the whole body dose, even when additional shielding materials were used on the glove box face. It became evident that doses assessed by the film badge were greater than those from LiF, by an average factor of 1.25 rising in some cases to as much as a factor of two. Measurements were therefore made to compare LiF and films with an air equivalent ionization chamber when exposed to radiation from the glove boxes. These measurements confirmed that dose estimates from films exceeded the true dose by a factor which depended on the hardness of the gamma x-ray spectrum. The reasons for overestimation are discussed and the conclusion made that LiF gives a good estimation of the true dose for a wide variety of fuels and exposure conditions. (France)

12305 MEASUREMENT OF THE DOSE RATE TO THE SKIN OF MAN, CONTAMINATED WITH β EMITTER NUCLIDES. Delpla, M.; Schaeffer, R. (Electricite de France, Paris). pp 135-45 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

LET values identified with the linear stopping power presented by tissues to electrons led to the establishment of an equation giving the dose rate in terms of the skin depth and the initial electron energy. Its application to the β energy spectra of the fission products from irradiated natural uranium led to the following values for the maximum permissible skin dose: 6 10^{-4} μCi/cm^2 for the major part of the body (continuous exposure) and 0.01 μCi/cm^2 (single exposure), and 5 and 7 10^{-3} μCi/cm^2 for the hands and feet (continuous exposure) and 0.1 μCi/cm^2 (single exposure). (France)

12306 DOSE TO BODY ORGANS FROM A SOURCE OF PHOTONS IN ONE OF THEM: VALIDITY OF THE RECIPROCITY THEOREM. Snyder, W. S.; Warner, G. G. (Oak Ridge National Lab., Tenn.). pp 146-53 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The results obtained using a Monte-Carlo computer code to estimate the dose per photon and the absorbed energy fractions in various body organs resulting from a uniform monoenergetic photon source (0.01 to 4 MeV) in one organ are described. This computer code is based on a homogeneous phantom divided into 22 regions defined by simple mathematical inequalities. The reciprocity theorem, if valid in such a heterogeneous medium as the body, would be of great value in estimating doses from low energy photons. This theorem, which was proved in the case of an infinite homogeneous medium, asserts that the average dose rate D1 in a region R1 from a uniform photon source in a region R2 equals the dose rate D2 in the region R2 from a uniform source of the same activity in R1. (France)

12307 ASSESSMENT OF EXTERNAL RADIATION EXPOSURE FROM HANDLING OF PLUTONIUM. Herrmann, G.; Hunzinger, W. (European Co. for the Chemical Processing of Irradiated Fuels, Mol, Belgium). pp 181-5 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

LiF dosimeters were used to determine hand exposures to γ radiation and for measurements on the γ rays emitted by Pu sources. Exposure rates up to 2 R/h were measured at the surface of processed plutonium oxide containers and γ ray doses to the hands were, at the maximum, 100 millirems per kilogram of plutonium handled. Since the exposure rates will be even higher for nuclear reactor fuels with higher burnup and the throughput will be increased, local shielding with only very limited direct handling of the Pu filled container is necessary. (France)

12308 PARTICULAR ASPECTS OF PERSONAL DOSIMETRY AROUND RADIOLOGICAL INSTALLATIONS. Busuoli, G. A. (Comitato Nazionale per l'Energie Nucleare, Bologna); Cavallini, A.; Renzi, R. pp 240-7 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The radiation doses received by radiology personnel and patients depend upon the kind of installation, its position, the protection equipment, and the type of x ray examination or therapy. In x ray diagnosis, the contribution of various types of examination to the total dose absorbed by patients was studied. A particular type of examination (gastrointestinal tract) was selected and the dose measured at different points in the body. Considering all the fields of application of x-ray sources, the dose received during the same working time may vary greatly according to the radiation protection measures employed. (TSS) (France)

12309 DOSE EVALUATION MEASUREMENTS FOR INHALED ^{133}Xe. Guillot, P.; Giubileo, M. (Joint Nuclear Research Center, Ispra, Italy). pp 289-309 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Curves representing the retention and elimination of inhaled ^{133}Xe were constructed from the results of various experiments involving the inhalation of ^{133}Xe over a period of several minutes. The following facts were observed: xenon passes into the blood and is rapidly distributed throughout the body; the distribution of xenon in the body does not vary during the measurement interval (5 to 6 hours); xenon is eliminated by the respiratory system; traces are found in the urine; the activity of ^{133}Xe in the exhaled air decreases with time. The internal radiation doses are absorbed principally by the upper respiratory system and the lungs. For a total inhaled activity of one millicurie of ^{133}Xe, 75 millirads are absorbed by the respiratory system, while the remainder of the body absorbs only four millirads. (France)

12310 CORRELATION BETWEEN DOSE AND LEUKOPENIA WITH IRRADIATED ANIMALS. Bonet-Maury, P.; Duplan, J. F.; Kahn, T. (Institut du Radium, Orsay, France). pp 332-5 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The regular correlation existing between leukopenia produced in mice and guinea-pigs and the absorbed doses of low LET ionizing radiations (x, γ, protons, and deuterons) allows the leukocyte count to be used as a method of biological dosimetry. High energy radiation measurements made using this method are compared with those obtained using physical methods (dosimetric films, glasses, thermoluminescent dosimeters) or chemical methods (ferrous sulfate). Good agreement between the results was obtained. (France)

12311 DOSIMETRY AND RADIOBIOLOGICAL EFFECTIVENESS OF A 400 MeV NEUTRON BEAM. Baarli, J. (European Organization for Nuclear Research, Geneva); Sullivan, A. H.; Buhrer, G.; Quintiliani, M.; Bianchi, M. pp 346-50 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The dosimetry and radiobiological effects of the 400 MeV neutron beam from the CERN synchro-cyclotron are discussed. An attempt is made to analyze the radiation dose obtained from measurements with a tissue-equivalent ionization chamber which was exposed in the beam and at a depth of 20 cm in a tissue-like absorber. The data obtained are discussed, together with the observed radiobiological effects of the same beam as measured by the survival of type B spermatogonia in mice and the induction of abnormal anaphases in Vicia Faba. (France)

12312 QUALITY, DISTRIBUTION, AND OTHER RELEVANT FACTORS IN SETTING MAXIMUM PERMISSIBLE DOSES FOR ^{125}I. Feige, Y. (Israel Atomic Energy Commission, Yavne); Gavron, A.; Gross, J. pp 351-6 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Iodine-125 decays by electron capture to the 35.5 keV excited level of ^{125}Te, which returns to its ground state predominantly by internal conversion. About 1.3 x rays with energies between 27 and 31 keV, and about 6.5 Auger and conversion electrons with an average energy of a few keV, accompany each decay. The ^{125}I thus ends up after decay as multiply ionized ^{125}Te ion, with an average positive electric charge of about 6. In calculating the radiation dose to the thyroid, a distribution factor must be taken into account, as the range of the electrons associated with the radioactive transformation of ^{125}I is small compared with the diameter of the colloidal fluid inside the follicle, where the thyroid hormones are stored. Furthermore, the low energy of these electrons warrants the consideration of a quality factor, especially for the Auger electrons, whose linear energy transfer is comparable with that of protons of a few MeV. The derivation of these two modifying factors from physical considerations and thyroid histology is presented. The limitations of deriving the maximum permissible thyroid burden for ^{125}I from the established values of ^{131}I are discussed. (France)

12313 MEASUREMENT OF THE ABSORBED DOSE AND RELATIVE BIOLOGICAL EFFECTIVENESS OF MEAN AND LOW ENERGY X-RAYS (260-55 kV). Wambersie, A. (Univ., Louvain, Belgium); Dutreix, A. pp 357-64 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The variations in the R.B.E. of x rays with energies in the 200 kV range were studied, using bacterial survival as the biological criterion. Three radiations were compared: x rays emitted with an accelerating potential less than 250 kV, where the equivalent energy = 98 keV; x rays emitted with an accelerating potential less than 260 kVp, where the equivalent energy = 58 keV; x rays emitted with an accelerating potential less than 200 kV, where the equivalent energy = 43 keV. Values of 0.96 ± 0.04 and 0.98 ± 0.03 were obtained for the RBE of 98 and 58 keV x rays, using 43 keV as a reference. A calibrated ionization chamber was used for the dosimetry. The $FeSO_4$ G values were determined for the three types of radiation. The RBE were then determined for 85 kV and 55 kV radiations; these correspond to an equivalent energy of 25 keV, and 17 keV, respectively. For the dosimetry based on $FeSO_4$, values of 13.4 and 13.3 were assumed for G. The $FeSO_4$ solution and the bacterial suspension were irradiated in thin layers under identical geometrical conditions. The RBE values obtained were 0.99 ± 0.11 and 1.01 ± 0.07, respectively. (France)

12314 APPLICATION OF THE MICRODOSIMETRY TO THE ANALYSIS OF RADIOBIOLOGICAL EFFECTS. Oda, N. (Tokyo Inst. of Tech.); Numakunai, T.; Ohtani, S. pp 381-6 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The concept of the microdose was applied to the evaluation of the effective cross sections of enzyme inactivation for several kinds of radiations (^{60}Co gamma rays and heavy ions). Results are compared with the conventional target theory based on the macrodose. The implications of the concept of microdosimetry in evaluating the biological effects of radiations are discussed. (France)

12315 MODEL CALCULATIONS OF DEPTH DOSE CURVES ON WATER AND GRAPHITE FOR 1250-keV PHOTONS RADIATION. Appendix to the Publication 140/2 (1970), 185. Abedin-Zadeh, R. (IAEA, Vienna); Eisenlohr, H. H.; Jayaraman, S. Strahlentherapie; 142: No. 2, 183-4(Aug 1971). (In German).

In the previous publication published in NSA 25: 16145, the energy-range relation was calculated for energies between 0.15 and 0.8 MeV. By taking into consideration several neglected factors, the calculations are now extended into higher energy ranges. Mathematical formulas as well as depth dose distributions are given for water and graphite. The ion doses produced by one photon of the energy 1250 keV amounts to 6.24×10^{-10} R. (H.B.G.)

12316 DOSE DISTRIBUTION MEASUREMENTS OF THE INTRACAVITARY AFTER-LOADING UNIT "CATHETRON" AND THEIR APPLICATION IN GYNECOLOGICAL USE. Vilhonen, Erkki; Groenroos, Matti; Maennikkoe, Martti (Univ., Turku, Finland). Strahlentherapie; 142: No. 2, 151-5(Aug 1971).

The Department of Radiotherapy, University of Turku, has been using a high-dose-rate after-loading unit Cathetron for about a year in the treatment of gynecologic cancer. The dose distributions of the ^{60}Co sources of the Cathetron were determined both experimentally by the TLD system and theoretically. The Cathetron was used parallel with radium therapy. The experience gained so far suggests that many cases previously managed by radium can now be treated by the Cathetron. (auth)

12317 DETERMINATION OF THE DOSE DISTRIBUTION IN THE TREATMENT OF THE CARCINOMA OF THE CERVIX BY PENDULUM IRRADIATION WITH X RAYS, BY MEANS OF A COMPUTER WITH DIGITAL OUTPUT. Lobodziec, Wlodzimierz; Szender, Jerzy (Onkologische Institut, Gliwice, Poland). Strahlentherapie; 142: No. 2, 164-73(Aug 1971). (In German).

A method of determining the dose from pendulum irradiation with x rays is described. The dose distribution was calculated by a computer with digital output that permitted examination of the dose distribution for treatment of carcinomas of the cervix by pendulum irradiation in dependence on the parameters of the beam of rays and the medium. The results for x rays of a HVT of 2 mm Cu are tabulated. (auth)

12318 CHARACTERISTICS OF LiF THERMOLUMINESCENT DETECTORS IN THE DOSIMETRY OF HIGH ENERGY RADIATIONS. Strueter, Horst-Dieter (Ruhr Univ., Essen). Strahlentherapie; 142: No. 2, 174-82(Aug 1971). (In German).

An adapted normalizing method is discussed considering the change of sensitivity as a result of slight variation of annealing conditions, nonlinearity of the dose dependence, and change in the reflection characteristic of the heater planchet. The accuracy and linearity of the dose measurements and the energy dependence for betatron radiations are described. Depth dose curves are shown for 5 to 43 MeV electrons and 43 MV bremsstrahlung with special consideration of the built up region and the depth depending LET change. Measurements with LiF, ionization chambers, and films

of dose distributions for fixed and pendulum electron fields in the Alderson phantom are compared. (auth)

12319 IONIZING BACKGROUND RADIATION IN THE KOWARY BASIN. Pensko, Jerzy; Jagielak, Jan; Biernacka, Malgorzata; Zak, Alfred (Central Lab. for Radiological Protection, Warsaw). Nukleonika; 16: No. 5-6, 293-300(1971). (In Polish).

Results of terrestrial background radiation measurements made in the Kowary Basin, situated in the Karkonosze Mountains in Lower Silesia, Poland are presented. This basin is an interesting area because of the higher than the average for Poland concentration of natural radionuclides in the soil and rocks, and the occurrence of old dumps and exploited mining galleries. The results of these observations showed that the gamma-ray background is in the Kowary Basin twice or three times higher than in other parts of Poland. Gamma exposure rate measurements carried out along the bed of the river Jedlica and estimations of the concentration of natural radionuclides in soil samples collected in the close vicinity of the river showed a cumulative deposition of these radionuclides in the river bed. This observation was also confirmed by the higher concentration of radon in the upper affluents of the river Jedlica. These contaminations of the river bed are due to erosion of old dumps and mining galleries. (auth)

12320 MODEL SIMULATING PHOTON TRANSPORT IN A FINITE MEDIUM. Thames, Howard D. Jr. (Univ. of Texas, Houston). Math. Biosci.; 12: No. 1-2, 173-84(Oct 1971).

A method for computing absorbed dose due to ionizing ^{60}Co radiation in finite two-dimensional absorbers is presented in which only parameters describing the geometry of the source-target configuration are used as input. The solution of the model is shown to be the limit of monotone sequence. Application to radiation dosimetry for radiotherapy treatment planning is pointed out. (auth)

12321 TRITIUM BODY BURDEN OF SWINE FOLLOWING THE RUPTURE OF A LUMINOUS SOURCE ACTIVATED WITH ELEMENTAL TRITIUM. McNelis, D. N.; Moghissi, A. A.; Patzer, R. G.; McMillan, R. G. (Western Environmental Research Lab., Las Vegas, Nev.). Health Phys.; 22: No. 2, 161-4(Feb 1972).

The biological absorption of tritium released by the rupture of self luminous sources activated with elemental tritium was studied using swine. Sources were ruptured in open air or in an enclosed tent. While biological absorption of released tritium in the open air experiment was found to be 0.001% or less, a 70-fold increase in the biological absorption was observed during the experiment in a tent. An extrapolation of these findings to a similar human exposure indicates that the rupture of a 1 Ci source in an enclosure would result in a dose commitment of 230 mrem. (UK) (auth)

12322 CONCENTRATION OF URANIUM IN MAN AND HIS DIET. Hamilton, E. I. (Radiological Protection Service, Belmont, Eng.). Health Phys.; 22: No. 2, 149-53(Feb 1972).

From measurements of the concentration of uranium in normal human tissues, it was estimated that a 70-kg man (ICRP Standard Man) contains a minimum of ~100 μg U and a maximum of ~125 μg U. The concentration in items of food and prepared diet from the U. K. suggested a daily intake of ~1 μg U. (auth) (UK)

12323 MEASUREMENTS OF ^{232}Th IN NORMAL AND INDUSTRIALLY EXPOSED HUMANS. Clifton, R. J.; Farrow, M.; Hamilton, E. I. (Radiological Protection Service, Sutton, Eng.). Ann. Occup. Hyg.; 14: No. 4, 303-8(Dec 1971).

The concentrations of ^{232}Th in blood, bone, and urine of unexposed persons, and in urine from workers engaged in the thorium industry were measured. It is estimated that a 70 kg man contains 215 μg ^{232}Th in the total body. The concentration of ^{232}Th in air, diet and drinking water was also investigated. (auth) (UK)

12324 DOSIMETRY OF PULSED X-RAYS AND ELECTRONS FROM A LINEAR ACCELERATOR. Antoku, Shigetoshi; Sunayashiki, Tadashi; Takeoka, Seiji; Takeshita, Kenji (Hiroshima Univ.). Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 69-76(1971). (In Japanese).

The linear accelerator in this institute is being used for radiobiological studies by instantaneous exposures similar to that of the atomic bomb. To use ionization chambers for dosimetry of pulsed radiations from the accelerator, the ion-recombination and energy dependence of the ionization chambers were studied by comparing them with chemical and thermoluminescence dosimeters. The ionization chambers indicated lower readings than the true values by recombination of ions. Readings of an Ionex 0.6cc chamber were about 20% lower than those of the chemical and thermoluminescent systems at a dose rate of 1500 rad/min (1.7 esu/-pulse). The collection efficiencies of Ionex and Radocon dosimeters determined experimentally agreed with those calculated using 750 $V \cdot cm \cdot esu^{-1}$ as a constant μ in a theoretical formula. The sensitivity changes according to radiation and its energy were established for both dosimeters. The sensitivity increased by 7 to 9% for 10 to 30 MeV electrons and decreased by 0 to 5% for 10 to 35 MV x rays according to a ^{60}Co γ ray standard. Field homogeneities in effective fields (80% of total area) were less than 10% of both electrons and x rays in the therapy mode. They were less homogeneous for x rays in the research mode. It is difficult to incur a specific dose to biological materials using ionization chambers because of variations in collection efficiency by output from the accelerator. In this study, we were able to irradiate with specific doses within 2% using ionization chambers correlated with chemical dosimeters just before irradiation. Lack of homogeneity of fields was reduced by rotating the irradiation cage. (auth)

12325 INFLUENCE OF DENTAL RADIOGRAPHIC CONES ON RADIATION EXPOSURE. Ice, R. D. (Univ. of Michigan, Ann Arbor); Updegrave, W. J.; Bogucki, E. I. J. Amer. Dent. Ass.; 83: No. 6, 1297-1302(Dec 1971).

Radiation exposure was reduced significantly at 65 kvp with both the 8-inch or 16-inch open-ended lead-lined cones compared with that of open-ended nonlead-lined or short, pointed cones. At high kvp techniques (90 kvp), the radiation exposure was reduced significantly with the 16-inch open-ended lead-lined cone compared with that of the 8-inch open-ended lead-lined, the open-ended nonlead-lined cone, or the short, pointed cones. A significant reduction in the skin exposures at entry was obtained at 90 kvp technique over that of the 65 kvp technique. Because of the significant reduced radiation exposure indicated in this investigation, open-ended lead-lined cones should be included as standard dental procedure. (auth)

12326 ELECTROMYELOMETRIC DETERMINATION OF THE RADIATION DOSE IN THE LIVING ANIMAL. Schneiberg, Krzysztof; Ordysinski, Tadeusz; Szelc, Stefan (Inst. for Oncology, Gliwice, Poland). Strahlentherapie; 142: No. 3, 327-30 (Sep 1971). (In German).

The number of nucleated cells per 1 mm of the bone marrow-tissue is inversely proportional to the dose of ionizing rays in exposure of the whole body applied but once. This parameter hence proves to be valuable for a biological evaluation of the administered dose. Counts in histological preparations of bone marrow can be replaced by measuring the resistence of the tissue: this is the principle of electromyelometry. The advantage of this method consists in the fact that it can be carried out intravitally, besides it is easy and quick. The applicability of the method, though, is limited to the first 8 days following radiation exposure. Later (up to the 50th day after irradiation of rats) the electric findings of the number of nucleated cells do not correspond anymore with the histological method. The cause is not yet known; intracellular as well as extracellular factors could play a role in this. (auth)

12327 DEVELOPMENT AND USE OF A PROGRAM ROUTINE FOR THE OUTPUT OF COMPUTED AND MEASURED DOSE DISTRIBUTIONS. Schroeder, U. G.; Seeger, W. (Univ., Tuebingen, Ger.). Strahlentherapie; 142: No. 3, 312-21(Sep 1971). (In German).

A general program is described, which—proceeding from the relative dose values in a point-grid—computes the appropriate isodoses, recording it on a coordinate-writer. In contrast to other output methods, a considerable augmentation of the resolving power is achieved. The special interpolation method also gives good results in gross point-grids. This allows a strong reduction of the grid point rate, and consequently of the time to spend for the pointwise calculation or measurement of dose distributions. Based on its general arrangement, the program is multipurpose. Examples of its application are the evaluation of measured dose distributions and the comparison between experimentally found and calculated isodoses. (auth)

12328 OBLIQUE CONES FOR INTRACAVITARY ELECTRON THERAPY WITH THE 42 MeV-BETATRON. Kuttig, H.; Munzinger, H.; Chowdhary, V. (Univ., Heidelberg). Strahlentherapie; 142: No. 3, 299-302(Sep 1971). (In German).

There are described two oblique cones for intracavitary electron therapy with the 42 MeV betatron. The possible, experimentally found dose distributions for 5, 10, and 15 MeV are demonstrated. (auth)

12329 SCATTERED RADIATION CONTRIBUTION IN MICE AND RATS PARTIALLY EXPOSED TO 180KVp X-RAYS. Sunayashiki, Tadashi; Takeoka, Seiji; Antoku, Shigetoshi (Hiroshima

Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 77-80(1971). (In Japanese).

Scattered radiation doses in mice and rats partially exposed to 180 KVp x rays were measured using various dosimeters and phantoms, and the contributions of scattered radiations to total doses were evaluated. Although scattered doses at given points within a phantom shielded by lead plate were less than a few percent of those of direct x rays, contributions of scattered radiations to total volume doses increased with decreasing irradiation fields. The volume dose from scattered radiations amounted to about 70% of that from direct x rays for a field of 1 cm in diameter, the smallest field in this study, at the center of a mouse phantom. The contributions of scattered radiations were found to be 20 to 40% of the total volume doses according to field and phantom sizes. Biological effects of partial exposures may not only depend on doses from direct x-ray beams, but also on scattered radiations. These results indicated that doses from scattered radiations should not be ignored in the study of radiation effects on whole body by partial exposures. (auth)

12330 SOME ASPECTS OF NEUTRON RADIATION NORMALIZATION. Keyrim-Markus, I. B. (Inst. of Biophysics, Moscow); Kochetkov, O. A.; Tsvetkov, V. I.; Zolotukhin, V. G.; Obaturov, G. M. Health Phys.; 22: No. 2, 187-90(Feb 1972).

At present neutron radiation normalization is based on Snyder's and Neufeld's data on distribution of neutron dose equivalent in a semi-infinite tissue-equivalent slab for normal and one-sided incidence of monoenergetic neutrons upon it. But the normalization must take into consideration the essential self-screening of neutron radiation by a human body, the dependence of the tissue dose value and its distribution on the neutron spectral-angular distribution, the geometrical size of the body, etc. It is shown that if these factors are taken into consideration the surface dose equivalent for multi-sided neutron exposure is smaller per equal fluence than that for normal and one-sided exposure. Therefore a Li glass thermoluminescent neutron dosimeter if calibrated to register the air dose equivalent for a monodirectional beam of neutrons will register a higher dose equivalent than the real ones in a man exposed to an isotrope or two-sided fluence. In order to take into account the screening effect for normalization of neutron flux it is proposed to introduce the coefficient of isotropy of a human exposure such that the recommended maximum permissible neutron fluxes should be multiplied by an isotropic factor K or the measured dose equivalent in air should be divided by this factor. (auth)

12331 URINARY ^{90}Sr LEVELS OF JET PILOTS AND MAINTENANCE CREW IN JASDF. Sakaguchi, Eikazu; Seo, Saburo (Japan Defence Agency, Tachikawa). Koku Igaku Jikkentai Hokoku; 11: No. 1, 1-7(Jun 1970). (In Japanese).

Urinary strontium-90 levels of jet pilots, maintenance crew, and administrative personnel were determined at A Air Base (AB) in May 1969 and B Air Base (AB) in August 1969 as an index of internal radiation contamination. Urinary ^{90}Sr level did not significantly increase in pilot group and maintenance crew compared with the administrative personnel. All groups at B AB had higher urinary ^{90}Sr levels compared with each group at A AB where radioactive fallout sampling flight had been performed following the nuclear explosions in China. There were no significant differences among pilot group, maintenance crew and administrative group in both Air Bases. Body burdens of ^{90}Sr in those groups were not considered over the level of general Japanese. (auth) (Japan)

12332 ANALYTICAL REPRESENTATION OF THE DOSE FIELD OF A SINGLE BEAM OF THE TELEGAMMA THERAPY UNIT, ROKUS. Konstantinow, B.; Pentschew, Wl.; Karamitewa, Z.; Kuetschukowa, W. (Mathematical Inst., Sofia). Strahlentherapie; 142: No. 3, 322-6(Sep 1971). (In German).

Proceeding from the Sterling formula, an analytical expression is given for computer calculation of the relative dose at any point of the irradiated volume for the telegamma therapy unit Rokus with a source surface distance of 75 cm. In contrary to Sterling, σ was determined as a function of the field size. The comparison of calculated values and values found by experiments shows satisfactory agreement. By use of this formula the total dose, which is developed by irradiation with incomplanare beams, can be calculated. (auth)

12333 ESTIMATE OF THE GENETICALLY SIGNIFICANT DIAGNOSTIC ROENTGEN-RAY DOSE IN THE NETHERLANDS (1967). Beentjes, Lucas B. Nijmegen, Netherlands; University of Nijmegen (1969). 103p.

Data on one million diagnostic radiographic examinations in the Netherlands during 1967 were analyzed and it was estimated that an average dose of 20 mrem per year was received by the population. It was concluded that this dose was genetically significant and that efforts should be made to decrease it. (C.H.)

12334 RADIOACTIVE AEROSOLS PRODUCED BY RADON IN ROOM AIR. Mercer, T. T.; Stowe, Wm. A. (Univ. of Rochester, N. Y.). pp 839-50 of Inhaled Particles III. Vols. I and II. /Walton, W. H. (ed.). Old Woking, Eng.; Unwin Brothers Ltd. (1971).

From third international symposium on inhaled particles; London, England (14 Sep 1970).

The distributions of radioactivity with respect to particle size and the fractions of unattached air-borne decay products were measured for aerosols produced by radon when mixed with room air in a 2 m^3 animal exposure chamber. Measurements were made using a round-jet cascade impactor having a diffusion chamber in place of the first stage. The median aerodynamic diameters of particulate activity were consistently close to 0.2 μm. The fraction of airborne RaA activity that was not attached to particles averaged about 0.2, although values as high as 0.44 were observed. Particulate attachment rate constants averaged about 0.77 min^{-1} and the recoil fraction for RaB nuclei was about 0.8. The former are compared with various theoretical predictions. (auth)

Radiation Protection

Refer also to abstract 13391.

12335 (NP-19147) RADIOLOGICAL HEALTH AND SAFETY ASPECTS OF URANIUM MINING AND ORE TREATMENT. Safety Section Bibliography No. 3. Button, J. C. E. (comp.) (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1971. 23p. Dep. NTIS (U. S. Sales Only).

Two hundred and four references are listed alphabetically under the headings: environmental problems; external radiation measurement; general radiological health and safety aspects; historical aspects; internal contamination hazards, measurements and protection; medical aspects; monitoring programs; radiological exposure limits; standards and regulations; ventilation; and waste management. (Australia)

12336 FIFTEEN YEARS IN RADIOPROTECTION AGAINST THE X-RAYS PRODUCED BY TELEVISIONS. Berthaud, M.: Penotet, H. (La Radiotechnique Coprim, Suresnes, France). pp 175-80 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Data on the emission of x rays during the production and use of black and white and color television sets are reviewed. Measures taken to protect the viewers are discussed. (TSS) (France)

12337 ABSORBED DOSE IN MAMMOGRAPHY USING THREE TUNGSTEN AND THREE MOLYBDENUM TARGET TUBES. Palmer, R. C.; Egan, R. L.; Tanner, B. K.; Barnette, P. A. (Emory Univ., Atlanta). Radiology; 101: No. 3, 697-9(Dec 1971).

Absorbed tissue doses were measured in rads during mammography, using a breast phantom with three tungsten target x-ray target tubes and three molybdenum x-ray target tubes. Two tubes were prototypes; the other four are commercially available. (auth)

12338 HAZARDS OF RADIATION. Baird, J. C. Australas. J. Pharm., Sci. Suppl.; 52: No. 103, S65-8(Sep 1971).

The possible hazards during the preparation and medical uses of radioisotope-labeled pharmaceuticals are considered. The effects of radiation on living tissue and chemical structures, and factors upon which these effects depend such as dose and rate of absorption are briefly reviewed. Radiosensitivity of cells is discussed with a comparison between dose and type of injury. (TSS) (Australia)

12339 ACTUAL CONDITION OF SAFETY MANAGEMENT IN NON-DESTRUCTIVE INSPECTION FACTORY. Katsurayama, Y. (Kyoto Univ., Osaka); Furuta, J.; Yamaguchi, T. Genshiryoku Kogyo; 17: No. 9, 36-42(Sep 1971). (In Japanese).

Non-destructive inspection using radiographic techniques in most cases is carried out by contractors who employ work teams of several persons. The work is performed in locations remote from central offices and workers cannot be fully supervised when poor communication exists between the workers and supervisors or managers. Since it is difficult to be assured of safe handling of radiation sources under these conditions it is im-

portant to monitor the working environment, establish controlled areas, inspect the apparatuses used, have a safety patrol, and establish training programs in radiation protection for workers. This is especially important in the case of small scale contractors. Such contractors should prepare a complete manual of practicing procedures and provide training sessions conducted by third party organizations. (TSS) (Japan)

12340 MANUAL OF RADIOBIOLOGY AND RADIOPROTECTION. Ghys, Roger. Paris; Maloine (1971). 280p. (In French).

This manual for radiologists and radiological technicians covers in fourteen chapters the different aspects of radiotherapy: the radiations used, the radioisotopes used, and biological effects. A large part is devoted to protection against radiation for patients and working personnel, to factors enabling the exposure to be minimized, and to the appropriate safety measures. An extensive bibliography is included. (France)

Safety Procedures

Refer also to abstract 12188.

12341 (BNWL–1550(Pt.1), pp 93) SPACE NUCLEAR SYSTEM STUDIES. (Battelle Pacific Northwest Labs., Richland, Wash.).

Space vehicles containing nuclear reactors or radionuclide power sources present special hazards in case of early abort or upon return from orbit. These problems are principally concerned with the biological effects of intensely radioactive small insoluble particles. We have studied and previously reported on the deposition and retention kinetics of inhaled particles, and are retaining a number of dogs for observation of long-term effects. No important results were obtained during 1970. (auth)

12342 EXPERIENCE IN THE CONTROL OF RADIATION DOSE IN UNITED KINGDOM CIVIL NUCLEAR POWER STATIONS. Emmerson, B. W. (Bradwell Nuclear Power Station, Eng.); Goldfinch, E. P.; Skelcher, B. W. Health Phys.; 21: No. 5, 643-9(Nov 1971).

This paper is based on the operational experience gained during the past 9 yr at the three civil nuclear power stations operated by the South Eastern Region of the Central Electricity Generating Board. These stations, Bradwell, Dungeness, and Sizewell, were commissioned between 1962 and 1966 and are similar in type, each having two gas cooled graphite moderated reactors, fuelled with natural uranium, and are operated on base load generation at high load factors. Methods of radiation control adopted at the stations and typical dose rates and contamination levels found in practice are reported. Details are given of the accumulated dose to various groups of workers, and the range and variation in environmental dose rates is discussed. These doses are contrasted with the current ICRP recommendations. It is shown that there is no difficulty in meeting these. It is shown that on the basis of accrued annual dose, the number of persons who have exceeded 1.5 rem per yr is less than 3% of the total staff employed, with an average dose of 0.08 rem per 10^6 KWH of electrical energy exported. (auth)

12343 RADIOLOGICAL PROTECTION IN THE CENTRAL ELECTRICITY GENERATING BOARD. Bonnell, J. A.; Dale, G. C. (Central Electricity Generating Board, London). Health Phys.; 21: No. 5, 637-42(Nov 1971).

The establishment of the Central Electricity Generating Board and the functions of the Nuclear Health and Safety Department are explained. The various aspects of the CEGB's radiological protection policy and how it has been implemented are described. The operational experience and unexpected problems encountered over the past 8 yrs are discussed. (UK)

12344 INDIVIDUAL PROTECTION AGAINST IONIZING RADIATIONS. Szvercsak, Maria. Munca Sanit.; 18: 461-5(Aug 1970). (In Rumanian).

Among the measures of individual protection against ionizing radiations, medical survey of the persons exposed is of particular importance, apart from the protection clothes and technical protection equipment. This includes: medical examination on engagement, periodical control examinations, evidence of the exposed sites of work, limited duration of work in such sites, irradiation file cards and dosimetry. The ancillary staff must be acquainted with these aspects of work carried out in an environment exposed to ionizing radiations and know to apply the measures of prevention and control. (auth)

12345 IONIZING RADIATION AND MAN: THE BIOLOGICAL HAZARDS. Burch, Philip R. J. (Univ. of Leeds, Eng.). Int. J. Environ. Stud.; 2: 211-16(1971).

A description is given of the problems of estimating the biological hazards to man resulting from exposure to small doses of ionizing radiation. Unequivocal evidence for harmful effects has generally involved high absorbed doses: the main difficulty is to know how to extrapolate from high to low doses. Extrapolation calls for a theory that can furnish dose-response relations, and allow for the influence of known modifying factors such as dose-rate, dose-fractionation and radiation quality. Relevant experimental evidence for the mutational and life-shortening effects of radiation on mice is reviewed. Epidemiological evidence for the effects of radiation on U. S. radiologists is used, in conjunction with theory, to assess the consequences of the maximum permissible occupational level, which is currently 5 rem/year. Over the age-range 35 to 79 years, overall mortality-rates might be expected to increase by a factor of about 1.02 over those in an unexposed population. This estimated increase of 2% could well be in error by a factor of three. No obvious short-cuts to more precise estimates suggest themselves. (UK)

Civil Defense

12346 CHTO NADO ZNAT' O VEDENII SPASATEL'NYKH I NEOTLOZHNYKH AVARIINO-VOSSTANOVITEL'NYKH RABOT V OCHAGE YADERNOGO PORAZHENIYA. (What You Should Know About Rescue and Emergency Recovery Operations in a Nuclear Strike Zone). Tsivilev, M.; Nikanorov, A. Moscow; Izdatel'stvo Dosaaf (1968). 48p.

The consequences of a nuclear explosion in a city are briefly described, and the general characteristics of such a disaster are examined. Procedures for rescue missions and emergency operations are recommended. Basic safety rules for civil defense workers in the ground zero zone are given. (tr-auth)

Legal Aspects

12347 METROLOGY IN HEALTH PHYSICS AND THE ICRU. Neufeld, Jacob (Oak Ridge National Lab., Tenn.). Health Phys.; 21: No. 5, 715-18(Nov 1971).

It is pointed out that the ICRP, by itself rather than jointly with the ICRU, should make recommendations in the radiation protection field. Thus, since recommendations on the basic aspects of radiation protection are prepared and issued by the ICRP, the definitions used therein should be made by the same group that issues recommendations. Also it is claimed that certain pursuits of the ICRU seriously hamper the free exchange of ideas essential to progress in health physics metrology. (UK)

12348 GOETTINGER ATOMRECHTSKATALOG. GOETTINGEN ATOMIC ENERGY LAWS CATALOG. VOLUME 1 THROUGH 21. Goettingen, Ger.; Institut fuer Voelkerrecht der Universitaet Goettingen (1960–1970). 21 volumes. (In several languages).

Legislation, regulations, and treaties relevant to atomic energy are compiled alphabetically by countries. Recommendations of national and international organizations related to radiation protection and bibliographies are included. The titles of each cataloged item are presented in English, French, and German languages. (C.H.)

Medicine

Protective Substances

Refer also to abstracts 11771, 11776, 12241, 12242, 12248, 12257, and 12413.

12349 KINETIC REGULARITIES OF THE RADIOSENSITIZING EFFECT OF HALOGENATED ANALOGUES OF TIMIDIN. Pelevina, I. I.; Afanas'ev, G. G.; Lipchina, L. P.; Emanuel, N. M. (Inst. of Chemical Physics, Moscow). Tr. Mosk. Obshchest. Ispyt. Prir.; 32: 190-2(1970). (In Russian).

The administration of 5-iodo-2-deoxyuridine to mice with subcutaneously inoculated lymphosarcoma NKLy, prior to local irradiation of the tumors, enhances the lethal action of irradiation on the tumor cells, as evidenced by the greater number of resorbed tumors. The degree of sensitization depends on the dose of the administered preparation. Unresorbed tumors continue to develop at the same rate as with irradiation alone. When 5-chloro-2-deoxyuridin is administered in conjunction with irradiation its effect is additive only. (auth)

12350 EXPERIMENTAL INVESTIGATIONS ON RADIATION PROTECTION BY ETHANOLAMINE. Heitmann, Hans Joachim; Sturde, Hans-Carl; Gorschlueter, Klaus (Ruhr-Univ., Bochum, Ger. Zentralkrankenhaus der Bundeswehr, Koblenz, Ger.). Strahlentherapie; 142: No. 1, 93-5(Jul 1971). (In German).

The experimental studies deal with the influence of ionizing rays on a solution of histamine in presence of ethanolamine. At a dose of 8000 R a significant loss of activity of an aqueous histamine solution has been observed, that could be decreased, if ethanolamine was added before the irradiation. The radiation dose of 8000 R is correlated quantitatively with the protective effect of different amounts of ethanolamine. Living isolated intestines of guinea pigs serve as very sensitive biological testing material. At a dose of 8000 R an addition of about 192 μg/ml of ethanolamine is required to protect an aqueous solution of histamine (1 μg/ml) against radiation induced loss of activity. (auth)

12351 PROTIVOLUCHEVYE SVOISTVA INDOLILALKILAMINOV. (Radioprotective Properties of Indolylalkylamines). Zherebchenko, P. G. Moscow; Atomizdat (1971). 199p.

A survey was made of the radioprotective characteristics of a large number of compounds related to the indolylalkylamines, and a correlation with chemical structure was attempted. Entire chapters are devoted to the subjects of synergism and antagonism in connection with this class of amines. The toxicity of indolylalkylamines and aminothiols, and factors responsible for intensifying or reducing their toxicity are discussed. The role of other pharmacological properties of these compounds is summarized. 902 references. (K.S.W.)

12352 INTERFERENCE WITH RESPIRATORY CONTROL BY IONIZING RADIATIONS IN ESCHERICHIA COLI B/r. Swenson, P. A.; Schenley, R. L.; Boyle, J. M. (Oak Ridge National Lab., Tenn.). Inst. J. Radiat. Biol.; 20: No. 3, 213-23(1971).

Irradiation of log-phase Escherichia coli B/r cells with ^{60}Co γ rays (30 krads) caused respiration to cease about 40 min after irradiation. When glycerol was the carbon source, cessation was complete for several hrs. Addition of casamino acids or substitution of glucose for glycerol favored early recovery. Respiration did not turn off when 5-fluorouracil, rifampin, or chloramphenicol was added immediately after irradiation. In all these situations the behavior of γ-irradiated cells resembled that of cells irradiated with uv light, and it is concluded that in both cases RNA synthesis and protein synthesis are necessary for respiration to be turned off. Unlike uv-irradiated cells, in which an early increase in viability is favored by maintenance of respiration with fluorouracil treatment, addition of this to γ-irradiated cells completely prevents even the normal exponential increase in viability, which begins about 60 min after irradiation. It is concluded that RNA synthesis is necessary for a step in the repair of DNA or in the subsequent recovery process. (auth)

12353 MECHANISM OF RADIOPROTECTION BY CYSTEINE AND CYSTEAMINE: ESR STUDIES OF IRRADIATED BINARY AND TERNARY SYSTEMS OF DNA AND TMP. Milvy, Paul (New York Univ., N. Y.). Radiat. Res.; 48: No. 2, 206-15 (Nov 1971).

ESR spectroscopy studies of free radical transfer or migration in binary and ternary systems of DNA or TMP and cysteamine and cysteine were conducted. DNA–cysteamine, DNA–cysteine, and DNA–cysteine–cysteamine samples were prepared by adding the thiols to concentrated solutions of DNA and freeze-drying the solution. TMP–thiol samples were similarly prepared. The samples were irradiated in vacuo at 77°K, and ESR spectra were recorded at this temperature before and after heat treatment. In the binary samples containing cysteine, no migration of spins from the target molecule to the cysteine was observed, while large migration of spins was achieved when using cysteamine. In the ternary samples of DNA–cysteine–cysteamine, large transfer of spins from DNA to thiol protector was observed in both native and denatured preparations. The conclusion that the cysteine does not interfere with radical migration to cysteamine seems warranted. In the TMP ternary system, however, complete inhibition of spin migration is achieved by the addition of cysteine. No homo- or mixed disulfides are formed in the preparations prior to irradiation. Previous workers have shown that in TMP these two thiols bind to different sites and our results are discussed with this in mind. (auth)

12354 EXPERIMENTS ON THE RADIOPROTECTIVE EFFECT OF THE SULPH-HYDRYL COMPOUNDS N-ACETYL-HOMOCYSTEIN-THIOLACTON AND CYSTEIN IN COMBINATION WITH FRUCTOSE. Ritter, Karsten (Institut fuer Allgemeine und Experimentelle Pathologie, Mainz). Strahlentherapie; 142: No. 1, 96-104(Jul 1971). (In German).

The radioprotective effect of the sulfhydril compounds n-acetyl-homocystein-thiolactone and cystein in combination with fructose (Reducdyn®) with different application doses of the radiation protection substance (RPS) and changing times of application before and after irradiation were tested. A total of 540 mice were treated in groups by whole-body irradiation with 500, 1000, or 2000 R. Reducdyn® was injected intraperitoneally in doses of 0.1, 0.25, 0.5, and 1 ml. These different doses of RPS were given while irradiations of 1000 R were used, besides that before and 6, 12, 24, and 48 hrs before and after irradiation. The results show that increased radiation doses resulted in decreased RPS. The irradiation protection itself depended upon the dose of RPS. Reducdyn® used as prophylactic treatment 48 hrs before as well as 24 hrs after irradiation produced a significant radiation protection that can be proven by statistics. (auth)

12355 TREATMENT OF THE MICE IRRADIATED LETHALLY WITH ^{60}Co γ-RAY BY USING THE BONE MARROW TRANSPLANTATION. 2. THE COMBINATION THERAPY OF BONE MARROW TRANSPLANTATION AND CHEMICAL PROTECTIVE AGENTS. Niimi, Masanobu (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 238-65(1971). (In Japanese).

In radiation protection experiments using AET and allogeneic bone marrow the combined treatment of lethally irradiated mice with chemical protection and bone marrow transplantation, in which the bone marrow was obtained for preirradiated donors with or without protective agents to suppress the secondary disease was attempted. From these experiments, some reported the effectiveness of the methods, and others the ineffectiveness, to prolong the lives of the irradiated mice. Even if these methods were effective under some conditions, because it was difficult to apply AET to mammalians except for mice, similar experiments were conducted using glutathione or serotonin instead of AET. Moreover, we counted the number of spleen colonies formed by similar experimental systems to the protective experiments described before, and compared it with the length of the life. Results are reported on the following experiments: observation of the survival of mice treated with glutathione or serotonin, irradiated with a lethal dose or several ultralethal doses of ^{60}Co γ ray and transplanted with bone marrow; the effect of bone marrow transplantation and chemical protective agents on the number of spleen colonies. (E.R.B.)

12356 STUDY ON THE INFLUENCE OF CERTAIN SUBSTANCES ON THE UTILIZATION OF ^{59}Fe IN IRRADIATED ANIMALS. Uray, Z.; Farcasanu, M.; Ursu, G.; Onisor, M.; Maniu, M. (Institut Oncologique, Cluj). Atomkernenergie; 18: No. 4, 327-8(1971). (In German).

Studying the radioprotective effect of certain classic radioprotective compounds (AET, MEA) and of some psychotropic drugs (antidepressant and neuroleptic drugs) within the sublethal field of x-ray irradiation (100 R, 150 R), using as test the incorporation of radioiron in the erythrocytes, a significant radioprotective effect of these substances was demonstrated. In comparing the test of radioiron utilization by animals irradiated with sublethal doses to a 30 day survival test by animals irradiated with lethal doses, good parallels concerning the effectiveness of the radioprotective substances were obtained. (auth)

Radiation Sickness and Injuries

Refer also to abstract 12544.

12357 LEUKOCYTIN: A NEW AGENT FOR THE TREATMENT OF RADIATION LEUKOPENIA. Gorizontov, P. D.; Kalyaeva, T. V.; Rogozkin, V. D. Patol. Fiziol. Eksp. Ter.; No. 1, 54-9 (1971). (In Russian).

The recently developed hematopoiesis stimulant leukocytin (containing the glycosidal alkaloid solanine) was administered orally to rabbits (15 ml) and dogs (30 mg) every other day from 1 to 20 days after whole-body x irradiation (450 to 500 R and 400 R, respectively). The preparation diminished the degree of leukopenia and degenerative changes in the spleen and bone marrow, preserved mitosis, and accelerated the regeneration of hematopoietic cells. Leukocytin, approved by the USSR Pharmacological Committee for use in the treatment of acute radiation sickness, is not a specific antiradiation agent and it can apparently be used for leukopenia due to other causes than radiation. The preparation is nontoxic (the authors tested it on themselves). (JPRS)

12358 CROSS-GENERATIONAL AND MEDICO-ANTHROPOLOGICAL PROBLEMS AMONG ALIEN A-BOMB SURVIVORS. Watanabe, Shoji (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 208-12(1971). (In English and Japanese).

It has been 25 years since the A-bomb explosions over Hiroshima and Nagasaki, and the passage of time has created for their survivors such new problems as aging and poverty. These problems are also significant for medical sociology and social policy. Since 1967, we were concerned principally with the Hiroshima survivors, with particular focus on changes in their living patterns. This research has reached a stage where, to deepen our understanding of the processes involved, a comparative study would be useful. The ideal group for this purpose are the alien survivors. Although accurate figures are lacking, their numbers,

including those connected with the armed forces, is placed in the tens of thousands. This group constitutes a comparable case for studying the interaction between physiological, psychological, and socio-cultural variables over time in A-bomb survivors. Moreover, this group is in itself worthy of interest. It has a unique history of immigration to Japan, survival of atomic disaster, repatriation to Korea, and survival in yet another conflict. An understanding of the consequences of these events on both the individual and the group would be instructive. (auth)

12359 EARLY DIAGNOSIS OF ACUTE RADIATION SICKNESS IN SHEEP. Kartashov, P. A. Veterinariya; 8: 82-4(Aug 1970). (In Russian).

Clinical examination of animals with varying degrees of radiation sickness has provided diagnostic criteria as a function of time elapsed since radiation. These criteria in the form of body changes and behavior are described. For example, one hour after extremely heavy radiation exposure, oppression, sluggishness, loss of appetite, and slight rises in body and skin temperature are noted. At 18 to 20 hr following exposure, diarrhea and malodorous feces are observed. At the end of the first day, body and skin temperatures return to normal. Diagnostics for smaller dosage are discussed. (K.S.W.)

12360 EFFICACY OF BONE-MARROW TRANSPLANTATION IN ACUTE RADIATION SYNDROME, COMPLICATED BY BURN. I. IRRADIATION IN THE CATABOLIC EARLY PERIOD OF THE BURN. Zographov, Dimiter G.; Krastanov, Dimiter K. (Institut fuer Aerztliche Fachschulung und Fortbildung, Sofia. Forschungsinstitut fuer Radiologie und Strahlenhygiene, Sofia). Strahlentherapie; 142: No. 2, 248-51(Aug 1971). (In German).

It was demonstrated on Wistar-rats that the transplantation of bone-marrow following irradiation with LD_{96-30} has no therapeutic effect, performed 24 hrs after infliction of a third-degree burn on 3% of the total body surface. The analysis of lethality distribution/time for the different test groups showed that bone-marrow transplantation on one side reduced the death rate through bone-marrow impairment on the 7th until the 9th day, whereas on the other side, rate of septical death increased markedly after the 10th day. The examination of endogenous and exogenous developmental processes of hematopoietic stem cells of mice, irradiated under the same conditions, showed that the burn did not influence either the endogenous stem cells or the transplanted hematopoietic stem cells. The author assumes that the therapeutic efficacy of the bone-marrow, transplanted under these conditions, is impaired by the consequences of burn, favoring a death from septicemia. (auth)

Radiodiagnosis

Refer also to abstracts 11951, 12112, 12115, 12201, 12300, 12308, 12312, 12325, 12333, 12337, 12340, 12395, and 12541.

12361 (CONF-710402-(Vol.1), pp II.9-17) MEDICAL AND DENTAL NEUTRON RADIOGRAPHY. A STATUS REPORT. Brown, Mark (Medical Coll. of Georgia, Augusta). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Research related to medical and dental applications of neutron radiography is reviewed. The capabilities and limitations of currently available techniques are discussed, and it is concluded that their clinical use will be restricted to in vitro studies and to in vivo studies involving small anatomical parts. The applications which appear to have the most promise for clinical use include studies in and about bone; techniques such as deuteration which selectively alter the ability of certain tissues to attenuate neutrons; those techniques which utilize monoenergetic beams and resonance absorption peaks to visualize internal structure; and neutron microradiographic techniques. (auth)

12362 (CONF-710402-(Vol.1), pp II.27-35) PRODUCTION OF TRACERS AND RADIOPHARMACEUTICALS. Green, B. J. (Abbott Labs., North Chicago, Ill.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The remarkable growth of nuclear medicine during the 25 years since the Atomic Energy Commission first made available artificially produced radioisotopes is primarily due to the increasing availability of radiopharmaceuticals in the dose and form desired by the user. It is estimated that about four million diagnostic tests are performed on patients each year by the nearly 8000 physicians who are licensed by the Atomic Energy Commission to use radioactive materials. Diagnostic radiopharmaceuticals can be classified into three categories: products for organ visualization; products for dynamic function studies; and products for in vitro studies. The history of the nuclear medicine field reveals that both radioactive iodine and the thyroid gland were most influential in its development. The development and success of commercial diagnostic kits for the determination of thyroid function using thyroid hormones labeled with radioactive iodine has paved the way for the commercial adaptation of newer and exciting in vitro diagnostic tests such as the radioimmunoassay. The day to day operations of a commercial supplier of radiopharmaceuticals are outlined stressing the importance of controlling the overall production system. (auth)

12363 (CONF-710402-(Vol.1), pp V.27-32) METABOLIC BONE DISEASES: BONE MASS AND CALCIUM BALANCE MEASURED BY TOTAL BODY NEUTRON ACTIVATION ANALYSIS. Denny, John D.; Nelp, Wil B.; Murano, Robert; Hinn, Gervas M. (Washington Univ., Seattle. School of Medicine); Palmer, H. E. (Battelle Pacific Northwest Labs., Richland, Wash.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The technique of total-body neutron activation and whole-body counting to estimate total-body calcium and calcium balance is described and 130 patient studies analyzed. Normal males had an average 1,098 grams of skeletal calcium (range 938 to 1,362) while patients with osteoporosis had only 698 grams (range 547 to 854). Two individuals with severe multiple myeloma had only 568 and 693 grams of total body calcium. Patients with renal failure maintained on chronic hemodialysis generally had a normal amount of total-body calcium (mean 1,052 grams, range 498–1,398), but as a group had an average loss of total-body calcium of 7% per year. A renal transplant recipient with persistent hyperparathyroidism post transplant had a 10% loss of total-body calcium in six months while two others without persistent hyperparathyroidism were in markedly positive calcium balance. Neutron activation analysis is an accurate and practical method for estimating bone mass and calcium balance. (auth)

12364 (CONF-710402-(Vol.1), pp V.33-8) CORRELATION OF RESULTS OF ACTIVATION ANALYSIS OF RAT AORTAS WITH RADIOCOBALT RETENTION DETERMINATIONS. Strain, William H.; Pories, Walter J.; Hill, Orville A. Jr. (Cleveland Metropolitan General Hospital, Ohio. Case Western Reserve Univ., Cleveland, Ohio. School of Medicine); Graber, Francis M. (Gulf General Atomic, Inc., San Diego, Calif.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Normal and atherosclerotic aortas from rats were analyzed by neutron activation to determine changes in the content of Ca, Cd, Co, Cu, Mg, Mn, Se, V, and Zn with the development of atherosclerosis. The results disclosed that with an increasing degree of atherosclerosis, the Ca content rose from <350 to 36,000 ppM; Co from undetectable to 0.34 ppM; Mg from <110 to 880 ppM; Mn from 0.99 to 1.26 ppM; and Zn from 77 to 152 ppM. Significant changes could not be detected in the Cd, Se, and V content, and Cu content changes were inconsistent. Accordingly, radioisotope uptake studies were conducted with ^{60}Co in young and old rats of both sexes to determine whether unusual retention patterns of this radionuclide were associated with atherosclerotic aortas and hearts. These data demonstrated much higher radiocobalt retention in the atherosclerotic aorta and heart tissue of older than of young rats. (auth)

12365 (CONF-710402-(Vol.1), pp V.39-45) MEASUREMENT OF IRON UTILIZATION IN PREGNANT WOMEN USING THE STABLE TRACER ^{58}Fe. Dyer, Norman C.; Brill, A. Bertrand; Goss, Donald A. (Vanderbilt Univ., Nashville, Tenn. School of Medicine). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Iron absorption, red blood cell incorporation, and maternal-fetal transport were measured in twelve normal, primagravida young women from 23 to 38 weeks gestational stage using ^{58}Fe as a stable tracer. Also, the maternal blood volume was measured using stable ^{50}Cr as a red blood cell label. The stable tracers were quantitated in maternal and infant blood samples by neutron activation analysis. The blood samples were irradiated in a research reactor and the induced radioactive nuclides of interest were determined by counting with a Ge(Li) detector-analyzer system. The average maternal blood volume normalized to the subject's surface area was found to be 2.57 L/M^2. The average percent incorporation into maternal red blood cells was measured as 63 ± 12%, while the average maternal gastro-intestinal absorption was measured as 51 ± 22%. The percent transport of the iron tracer from maternal plasma to the infant's circulating blood (as measured at birth) averaged 6.7 ± 3.8%. None of these parameters seemed to vary in a consistent pattern over the gestational range studied (23 to 38 weeks). Since the stable tracers, ^{58}Fe and ^{50}Cr, were used for this study and the quantita-

tion of the stable tracer was done by neutron irradiation of blood in vitro, there was no radiation exposure to the study subjects. (auth)

12366 (CONF-710402-(Vol.1), pp V.46-52) BLOOD VOLUME AND HEMORRHAGE TIMING IN NEWBORN INFANTS WITH RESPIRATORY DISTRESS USING THE STABLE TRACER, ^{50}Cr. Dyer, N. C.; Brill, A. B.; Faxelius, G.; Stahlman, M. (Vanderbilt Univ., Nashville, Tenn. School of Medicine). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Intracranial hemorrhage is a frequent finding at autopsy in newborn infants afflicted with respiratory distress. To guide the choice of therapy for infants with respiratory distress, it was important to determine whether intracranial bleeding occurred before therapy could be initiated. Infants at high risk for intracranial bleeding were transfused early in the course of their illness with red cells tagged with ^{50}Cr and ^{51}Cr in blood samples and clot samples, when available, were quantitated by neutron activation analysis. The samples were irradiated in the Georgia Institute of Technology Research Reactor and the ^{51}Cr activities were counted with a Ge(Li) detector-analyser system. The red blood cell volume was measured for 86 newborn infants with respiratory distress. Twenty-eight infants were found to have intracranial hemorrhage at autopsy. Of these 28 infants, 22 had their major bleed after they were tagged with ^{50}Cr, four probably bled both before and after tagging, and two indicated that their hemorrhage probably occurred before tagging. Since the stable tracer ^{50}Cr was used as the red blood cell tag and the determination was done by neutron irradiation of the blood in vitro, there was no hazard to the infant from nuclear radiation. (auth)

12367 BIOMEDICAL USE OF ACTIVATION ANALYSIS. Ohno, Shigeru (National Inst. of Radiological Science, Chiba, Japan). Hoshasen Kagaku; 14: No. 3, 9-11(Mar 1971). (In Japanese).

Radionuclides are produced as a result of a nuclear reaction between elements, that were irradiated by high-energy nucleons such as neutrons, protons, deuterons, α rays, and γ rays and their particles. By measuring produced characteristic-nuclides such as γ rays and β rays, their energy and half-life, it is possible to identify and determine specified elements. It is one of the characteristics that makes non-destructive analysis possible. Therefore, sensitivity is higher than the other analytic methods. Regarding application in the medical field, activation analysis is a useful method to determine normal concentrations of microelements in a living body, to research interrelations between concentrations of microelements in special organs or organisms and chronic pathological conditions, and also to research the distribution of specific elements to understand the metabolic process. It is indicated that measurement of protein-bound hormonal iodine in total plasma is useful as an indicator of the function of thyroid and that selenium binds mainly with α- and β-globulin and plays a partial role in the control of the oxidation-reduction balance in organisms along with vitamin E. Bromide was labeled to protein as a stable tracer and the biological half-life was measured using rats. Photonuclear activation analysis was applied to the analysis of fluorine in air pollution and thus the detection limit was raised to 0.005 ppM. Recent development of Ge(Li) semiconductor detectors encouraged the progress of activation analysis, particularly non-destructive analysis. (Japan)

12368 AREAS OF USEFULNESS OF RADIOACTIVITY TO THE PHARMACEUTICAL AND ALLIED SCIENCES. Christian, John E. (Purdue Univ., Lafayette, Ind.). Radioisotopes (Tokyo); 20: No. 9, 473-83(Sep 1971).

The discussion of the current and potential applications of radioactive isotopes has emphasized the uniqueness and versatility of this relatively new tool. The advancements that were made in the past twenty yrs using the described techniques were phenomenal, yet the surface of application and use with substantial advantage has just been scratched. As with any new technique there are difficulties encountered in acceptance and use, and radioisotopes are no exception in this regard. A number of factors have retarded the extended application of radioisotopes. The lack of trained personnel, the erroneous concept of the exceptional health hazards involved, waste disposal problems, the mistaken idea that ionizing radiation induces radioactivity into materials exposed to it, a concern about government regulations, uncertainty about the position that the Food and Drug Administration might take on approval of products exposed to ionizing radiation, and an assumption of high cost of utilization are all factors. These seeming drawbacks and difficulties to the use of radioactive isotopes and radiation in the pharmaceutical industry and medicine are more apparent than real and we can expect greatly increased acceptance of isotope applications and uses in the future. (auth)

12369 DATA PROCESSING OF RADIOISOTOPE IMAGES FOR OPTIMUM SMOOTHING. Barber, D. C.; Mallard, J. R. (Dept. of Medical Physics, Aberdeen, Scotland). Phys. Med. Biol.; 16: No. 4, 635-44(Oct 1971).

A digital method of data processing radioisotope scan images was used to derive a smoothing function for obtaining the best least mean squares fit of a noisy radioisotope image to the expected image. This was compared to smoothing with a Gaussian function where it is seen to give a better least mean squares fit. Approximate values for the relevant parameters are derived for a digitized thyroid scan. (auth)

12370 PLACENTAL SCANNING WITH ^{113m}In WITH PARTICULAR REFERENCE TO SOURCES OF ERROR. Connolly, Roger (Royal Hobart Hospital, Tasmania, Australia); Schokman, Christopher M. Aust. N. Z. J. Obstet. Gynaecol.; 11; No. 3, 170-3(Aug 1971).

There are blood pools in and around the gravid uterus other than those of the placenta. Radionuclide scanning to localize the placenta can be confused by these pools. The left uterine vessels are brought closer to the abdominal wall by dextro-rotation of the uterus and provide a particular source of confusion. This paper attempts to correlate the density of the photoscan with direct measurement of the distance of these vessels from the abdominal wall. Scans were made before operation, using ^{113m}In. The merits of photoscanning using this radionuclide are discussed. (auth)

12371 RADIOCARDIOGRAPHY USING HERTZIAN TRANSMISSION. Barritault, Lionel; Prieur, Gerard; Sejourne, Claude; Vernejoul, Pierre (CEA, Orsay, France). Ann. Phys. Biol. Med.; 5: No. 2, 97-114(1971). (In French).

An apparatus for externally measuring cardiac flow in man, using radioactive indicators, is described. It was developed to facilitate a flexible and easily usable system, principally concerned with the exploration of the cardiovascular function. The complicated and heavy classical installation was partially replaced and the apparatus incorporates a hertzian relay, which allows dilution curves to be established in all cases where the patient cannot be moved. The emitter and receptor sections are described and an emphasis is put on the problems encountered in the hertzian transmission of random information, and the solutions adopted. The performance of the apparatus is discussed. (France)

12372 MOBILE TB X-RAY UNITS: AN OBSOLETE TECHNOLOGY LINGERS. Nelson, Bryce. Science; 174: No. 4014, 1114-15(10 Dec 1971).

The radiation hazards to the public from the use of mobile x-ray equipment for chest radiography for screening programs for tuberculosis (TB) are reviewed. It is pointed out that the need for mass screening programs for TB in the USA has passed and that the skin tuberculin test is now the preferred method for screening populations. (C.H.)

12373 RENAL UPTAKE OF ^{99m}Tc-IRON-ASCORBIC ACID COMPLEX IN MAN. Hauser, W.; Atkins, H. L.; Richards, P. (Brookhaven National Lab., Upton, N. Y.). Radiology; 101: No. 3, 637-41(Dec 1971).

A complex of technetium 99m with iron and ascorbic acid was used for scintigraphic imaging of the kidneys. Eighteen patients were studied to determine renal excretion, plasma levels, whole-body retention, and renal localization. Two different methods of preparation of the material were utilized. The results indicate little difference between the two compounds. Total-body retention at twenty-four hours, measured by whole-body counting and urinary excretion, was about 25 to 31% of which 4 to 10% was in the kidneys. (auth)

12374 PLACENTAL SCANNING USING ^{99m}Tc-ALBUMIN AND IONIC ^{113m}In. Urbanek, Jan; Graf, Miroslav (Charles Univ., Prague). J. Nucl. Med.; 12: No. 12, 825-7(Dec 1971).

Placental scanning using ^{99m}Tc-albumin was performed in 34 patients, as well as with ^{113m}In-transferrin complex in 116 patients. The Anger scintillation camera and 1,600-channel analyzer were used for visualization. In six cases examination was completed by conventional placentography. In four cases it was possible to differentiate between low-lying placenta and placenta previa partialis. In 133 of the remaining 146 cases the diagnosis was verified by palpation or Caesarean section and found to be correct (auth)

12375 CYCLOTRON-PRODUCED ^{157}Dy COMPARED WITH ^{18}F FOR BONE SCANNING USING THE WHOLE-BODY SCANNER AND SCINTILLATION CAMERA. Yano, Y.; Van Dyke, D. C.; Verdon, T. A. Jr.; Anger, H. O. (Univ. of California, Berkeley). J. Nucl. Med.; 12: No. 12, 815-21(Dec 1971).

Some of the advantages of ^{157}Dy for bone scanning are 8.1-hr half-life, high yield of 326-keV photons, and decay by electron capture. When ^{157}Dy is administered as an HEDTA chelate in a molar ratio of 20:1 of HEDTA to terbium, uptake of activity is primarily in the bone with increased uptake in bone lesions. With ^{157}Dy-HEDTA, clearance from blood and soft tissues occurred within 3 to 5 hr after intravenous administration compared with 2 to 3 hr with ^{18}F. The slower clearance of ^{157}Dy, as well as a relatively lower extraction efficiency of bone, make ^{157}Dy a somewhat poorer bone-scanning agent than ^{18}F. (auth)

12376 PULMONARY SHUNT DETERMINATION: A COMPARISON BETWEEN OXYGEN INHALATION (BERGGREN) AND ^{133}Xe METHODS. Horovitz, J. H.; Carrico, C. J.; Maher, J.; Shires, G. T. (Univ. of Texas, Dallas). J. Lab. Clin. Med.; 78: No. 5, 785-93(Nov 1971).

A simplified technique for determining pulmonary arteriovenous admixture utilizing the isotope-dilution principle is presented. Xenon-133, which is a highly insoluble gas, is injected intravenously with an intravascular marker. The amount of shunted blood is directly proportional to the amount of xenon recovered in an arterial sample. Xenon-133 was combined with RISA or Hippuran-131 and was compared with the 100 percent O_2 method. The mean normal shunt value in the anesthetized dog was 4.9 percent ±2 for the Berggren method and 4.7 percent ±1.3 for the xenon method. Variable large shunts were created by ligation of lobar bronchi. Under these conditions, there was good correlation between the 2 methods (r = 0.9782). The xenon method is relatively simple and avoids the use of high inspired oxygen concentrations. (auth)

12377 ABOUT FOCAL DIAGNOSIS IN THE GYNECOLOGICAL RADIOTHERAPY. Alth, G.; Kratochwil, A.; Hofner, W. (State Hospital, Vienna. Univ., Vienna). Strahlentherapie; 142: No. 3, 303-7(Sep 1971). (In German).

It is shown that radiological localization and ultrasonic examination are methods complementing one another, rendering possible an exact gynecological irradiation plan through reproduction of accurate organ sites in the minor pelvis. The possibility of a direct observation of the tumor during therapy is discussed. (auth)

12378 LABELLED COMPOUNDS. pp 821-98 of Radioisotope Production and Quality Control. Vienna; International Atomic Energy Agency (1971).

See STI/DOC-10/128.

The principal characteristics of 45 radionuclides of 29 elements used most often for medical diagnosis, therapy, and research are tabulated. Methods for the preparation of a number of labeled compounds used as tracers in medical studies are described. Emphasis is placed on the preparation of compounds labeled with ^{125}I, ^{131}I, ^{51}Cr, ^{99m}Tc, ^{75}Se, ^{57}Co, ^{58}Co, ^{197}Hg, ^{203}Hg, ^{32}P, and ^{113m}In. (135 references) (C.H.)

12379 DIRECT COMPUTER DIAGNOSIS OF RHEUMATIC HEART DISEASE. Hall, D. L.; Lodwick, G. S.; Kruger, R. P.; Dwyer, S. J.; Townes, J. R. (Univ. of Missouri, Columbia). Radiology; 101: No. 3, 497-509(Dec 1971).

A system of computer screening of 14 × 17-inch chest radiographs and the identification of cardiac abnormalities for the diagnosis of rheumatic heart disease is described. The computer identifies the cardiac silhouette, measures its important parameters, and applies discriminant function analysis techniques to decide whether or not the heart is within normal limits; if not, the computer reports the likely type of abnormality within the spectrum of rheumatic valvular disease. With the use of the test library of normals and cases of rheumatic heart disease, the computer has a higher overall accuracy than the radiologists viewing the same library of proved cases. (auth)

12380 ANALYTICAL APPROACH TO DYNAMIC RADIOISOTOPE RECORDING. Ishii, Yasushi; MacIntyre, William J. (Case-Western Reserve Univ., Cleveland). J. Nucl. Med.; 12: No. 12, 792-9(Dec 1971).

To extend the clinical interpretability of externally monitored dynamic isotope data, an analytical approach using either an analog computer or digital computer has been accomplished. The present approach was based on the assumption that dynamic isotope data can be considered to be a series of input-output relationships in terms of the system concept which reduces the problem to simple consecutive steps either of parametric manipulation by analog computer or of graphical analysis by digital computer. An application of this analysis to the radiocardiogram (RCG) has been performed, resulting in clinically useful information concerning the fractional blood volume within right or left heart chamber and pulmonary blood volume in patients with or without congestive heart failure. (auth)

12381 LINEPRINTER DISPLAY OF DIGITAL SCINTISCANS. Hutchinson, F.; St. Clair Neill, G. D.; Rimmer, A. R. (Eastern Regional Hospital Board, Dundee, Scotland). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 113: No. 4, 755-64(Dec 1971).

Lineprinter display of digital scintiscan data is becoming more common due to the wider availability of computer facilities. The basic method of presentation is in the form of a contour map, using symbols to represent areas of different count rates. Various types of contour display are evaluated and criteria for choosing the optimum type for a given scanning situation are included. (auth)

12382 INHALATION PULMONARY SCINTIPHOTOGRAPHY USING PERTECHNETATE. Cook, David J.; Lander, Harry (Univ. of Adelaide). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 113: No. 4, 682-9(Dec 1971).

Inhalation lung scintiphotos of good quality with a minimum of bronchial deposition were obtained using a simple, inexpensive nebulizing system and ^{99m}Tc in the pertechnetate form. The method described is a rapid means of obtaining useful information regarding airway patency with no radiopharmaceutical preparation. Pertechnetate is a suitable radiopharmaceutical for inhalation lung studies providing scintiphotos are obtained during the inhalation phase and not exclusively after inhalation ceases, when pertechnetate is rapidly cleared from the lungs. (auth)

12383 PULMONARY SCANNING USING ^{99m}Tc LABELED MACROAGGREGATES OF ALBUMIN PREPARED ACCORDING TO A NEW AND SIMPLIFIED TECHNIQUE. Webber, Milo M.; Cragin, Michael D.; Victery, Wimona (Univ. of California, Los Angeles). Contract AT(04-1)-Gen-12. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 113: No. 4, 690-2(Dec 1971).

The use of macroaggregates of albumin incorporating ^{99m}Tc sulfur is a simple, time-saving technique which also conserves radiotechnetium. The method is very reliable and easily reproducible. The scans obtained are consistently of high quality with less background due to free pertechnetate than scans performed with macroaggregates of albumin labeled by our previously used methods. In the 110 patients studied with this agent, no adverse reactions or reasons for contraindications were observed clinically. (auth)

12384 INVESTIGATION OF MAJOR SALIVARY DUCT OBSTRUCTION BY SEQUENTIAL SALIVARY SCINTIGRAPHY. Schall, Gerald L.; Anderson, Larry G.; Buchignani, John S.; Wold, Robert O. (National Institutes of Health, Bethesda, Md.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 113: No. 4, 655-9(Dec 1971).

Sequential salivary scintigraphy (SSS) is a dynamic anatomic-functional radionuclide study in which the uptake, concentration, and excretion of ^{99m}Tc-pertechnetate by the major salivary glands are studied with a gamma camera. Three patients are reported who had obstruction of Stensen's ducts which was documented by both SSS and contrast sialography. Although these two procedures generally provide supplementary diagnostic information, SSS may be used to investigate the integrity of the major salivary ducts when sialography is contraindicated. (auth)

12385 ATLAS OF NUCLEAR MEDICINE. VOLUME 2. LUNG AND HEART. Deland, Frank H.; Wagner, Henry N. Jr. Philadelphia; W. B. Saunders Company (1970). 294p. $20.00.

Although the first radioisotope scans of lungs were performed as recently as 1963, the procedure is now widely used in medical diagnosis. It has also helped to expand knowledge of pathologic processes and understanding of the natural history of pulmonary diseases. The basic information obtained from lung scanning is the regional distribution of pulmonary arterial blood flow; one important contribution is the knowledge that essentially all diseases of the lung alter the normal flow pattern. Scanning is a sensitive but nonspecific index of pulmonary disease; however, knowledge of the way in which certain diseases affect the distribution of blood may make it possible to arrive at a more specific diagnosis. Of greatest importance is an understanding of the anatomy of the pulmonary arteries. Data are presented on cardiac as well as pulmonary diseases as studied with static images. Images from a new procedure known as nuclear angiography, which is proving increasingly useful for evaluating blood circulation through the heart, lungs, and great vessels and images obtained with a γ camera are included. The interpretations of the images are presented objectively as they were obtained, without prior knowledge of the patient and his problems. The evidence obtained from each study is considered in light of the clinical problem and other relevant information. (C.H.)

12386 ATTEMPT TO THEORETICALLY INTERPRET GAMMA-ANGIOENCEPHALOGRAPHY CURVES. Itti, R.; Planiol, T.; Floyrac, R. (Centre Hospitalier Regional Bretonneau,

Tours, France). Ann. Phys. Biol. Med.; 5: No. 3, 173-85(1971). (In French).

A simple mathematical model is described which explains radioisotope cerebral transit curves. It is based on the diffusion law with a convection velocity. The resulting transit time distribution is gaussian. Three parameters must be considered: the mean transit velocity, the transit time dispersion, and the vascular pool. Theoretical curves, calculated for different values of these parameters, are compared to curves observed during scanigraphy with various cerebral diseases. (France)

12387 CHERENKOV LIGHT FROM ^{32}P AS AN AID TO DIAGNOSIS OF EYE TUMOURS. Burch, W. M. (St. Thomas's Hospital, London). Nature (London); 234: No. 5328, 358(10 Dec 1971).

Reasons are given for the limited success of the ^{32}P uptake test as an aid to diagnosis of tumors in the posterior of the eye. It was found possible to detect the presence of ^{32}P in the back of the eye by observing the Cherenkov radiation produced by passage of the β-radiation through the vitreous humor. This can be done through the pupil using a highly sensitive photomultiplier tube, and the use of this method as a simple diagnostic test was investigated in the rabbit. The equipment used is described, together with details of the technique. Application to the diagnosis of human ocular melanomata is planned. (UK)

12388 QUANTITATIVE ORGAN VISUALIZATION IN NUCLEAR MEDICINE. Proceedings of 1st Biennial Conference, Miami, Florida, May 6-9, 1970. Kenny, Peter J.; Smith, Edward M. (eds.). Coral Gables, Fla.; University of Miami Press (1971). 928p. $20.00. (CONF-700516).

Forty-two papers discuss the advantages and disadvantages of radioisotope organ visualization for quantitative physiological studies. Emphasis is placed on radioisotope imaging systems; calibration procedures; methods for resolution enhancement; and computerized data acquisition, processing, and display systems. Diagnostic applications of radioisotope organ visualization are considered incidentally. (C.H.)

Radiotherapy

Refer also to abstracts 11929, 12294, 12297, 12316, 12317, 12320, 12327, 12328, 12332, 12340, 12427, 12513–12515, 12517, 12519, 12521–12523, 12542, 12543, and 12546.

12389 (CONF-710402-(Vol.1), pp II.1-8) CURRENT STATUS OF FAST NEUTRON TELETHERAPY AND BRACHYTHERAPY. Brennan, James T. (Pennsylvania Univ., Philadelphia. Dept. of Radiology). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Fast neutron teletherapy (neutron source at a distance from the patient's body) and fast neutron brachytherapy (^{252}Cf neutron source in contact with the body) are reviewed briefly with emphasis on areas in which progress has been made recently or in which critical problems exist. In reviewing the physical and biomedical aspects of the topic the individual papers contributed to this meeting and published herewith, are referred to in order to indicate how each of these individual contributions is related to the overall picture. (auth)

12390 POSSIBLE USES OF DENSELY IONIZING RADIATIONS IN RADIOTHERAPY. Bond, V. P.; Tisljar-Lentulis, G. M. (Brookhaven National Lab., Upton, N. Y.). pp 241-88 of Elementary Particles. Science, Technology, and Society. /Yuan, Luke C. L. (ed.). New York; Academic Press Inc. (1971).

The possibilities of using charged particles (protons, deuterons, α, neutrons, negative pions, and heavy ions) for therapy of neoplasms are reviewed. The advantages and limitations are considered. The present status of therapeutic trials is discussed. (62 references.) (C.H.)

12391 COMPLEMENTARY TREATMENT OF HODGKIN DISEASE BY IRRADIATED TUMOR EXTRACT. Latarjet, R.; Ennuyer, A. (Institut du Radium, Paris). Haematol. Lat. (Milan); 12: 397-406(Jul-Dec 1969). (In French).

The antiviral treatment for Hodgkin's disease was studied using the cancerigenic virus itself sterilized by irradiation. No conclusion could be drawn on the therapeutic value because of the small number of patients (23) treated. It could be concluded however that the tumor extract injections were not harmful to the patients. The irradiated extract did not prevent relapses, but the percentage of no relapse after five years was better for patients receiving the extract (60%) than for those not receiving the extract (40%). (J.S.R.)

12392 APPLICATION OF DATA ON THE DYNAMICS OF GROWTH OF INOCULATED TUMORS FOR THE STUDY OF THEIR RADIOSENSITIVITY. Konoplyannikov, A. G. (Inst. of Medical Radiology, Obninsk, USSR). Tr. Mosk. Obshchest. Ispyt. Prir.; 32: 134-6(1970). (In Russian).

A simple quantitative model of tumor growth is described showing an exponential increase in the number of cells in time. By determining experimentally the number of cells in the tumor, or the lifetime of the tumor-bearing animal, it is possible to estimate quantitatively the reproductive activity of the tumor cell population. On the basis of this principle a study was made of the radiosensitivity of leucosys La and Ehrlich ascites carcinoma. It is proposed to use the developed model for in vivo investigations of the radioprotective and radiosensitized effect, dynamics of restorative processes after irradiation, and relationships between the growth of irradiated tumor cell population and level of cytogenetic lesions in cancer cells. (auth)

12393 SARCOMAS OF THE MANDIBULAR REGION. Rintala, A.; Gylling, U.; Lahti, A.; Soivio, A. (Red Cross Hospital for Plastic Surgery, Helsinki). Scand. J. Plast. Reconstr. Surg.; 4: 109-13(1970).

Twelve sarcomas of the mandibular region were treated at the Finnish Red Cross Hospital for plastic surgery in 1951 to 1966. Five of them were in the soft tissues, the rest in the mandible. Four developed in a chronic radiation burn and one patient had an evident familial predisposition, but the other cases displayed no predisposing factors. All the patients were young with the exception of those with radiogenic sarcoma. The sarcomas generally grew rapidly and emitted scanty symptoms. The commonest and obviously recommendable therapeutic method was radical soft tissue excision and bone resection combined with postoperative radiotherapy. Five patients were alive and asymptomatic after a follow-up period of 10 yrs; one of the fatalities survived over five years, two over three years and one over a year from the establishment of the diagnosis. The great prognostic significance of the radicality of the first operation is emphasized. The methods for reconstruction of the soft tissues and the mandible in these cases are reviewed. (auth)

12394 POOR MAN'S NEUTRONS? Withers, H. R.; Chen, K. Y. (Univ. of Texas, Houston). Brit. J. Radiol.; 44: No. 526, 818(Oct 1971).

The use of low dose rate continuous and ultrafractionated γ radiation is briefly discussed as an alternative to neutrons for radiotherapy. It is argued that when cells are exposed to low intensities of x and γ rays, or to multiple fractions of sparsely ionizing radiations, then the high LET component would be responsible for a greater proportion of cell lethality, because injuries induced by low LET components would be continuously repaired. The hazards of ^{252}Cf as opposed to radium are mentioned. (UK)

12395 RELATIONSHIP OF THE THYROID SCINTISCAN TO THE THERAPEUTIC EFFECTS OF ^{131}I IN HYPERTHYROIDISM WITH DIFFUSE GOITER. Tjoe, Soen L.; Levine, Bennett; Wieland, Ralph G.; Chen, Jeffrey C. (Saint Luke's Hospital, Cleveland). J. Nucl. Med.; 12: No. 12, 804-7(Dec 1971).

Thirty-six cases of hyperthyroidism with diffuse goiter treated with ^{131}I were studied retrospectively. The therapeutic doses and clinical results of the patients were correlated with the characteristics of thyroid scintiscans. Results indicated that patients with hyperthyroidism and diffuse goiter without palpable nodules by physical examination revealed marked irregularity of distribution of radioactive iodine within the glands as determined by the thyroid scintiscan. Patients with an irregular distribution of radioactivity within the gland more often required multiple treatments and higher total dose for the control of hyperthyroidism compared with patients with homogeneous distribution of radioactivity within the glands. The incidence of post-therapy hypothyroidism was lower in the patients with irregular distribution of radioactivity within the gland. The pattern of radioactivity within the gland, as determined by the thyroid scan, was a good parameter in predicting the response to therapy, the likelihood of developing early hypothyroidism, and in determining the dose of ^{131}I to be used in treatment. There is apparently no dose of ^{131}I presently used in treatment of hyperthyroidism which will completely eliminate post-therapy hypothyroidism. (auth)

12396 INTRAUTERINE T-PROBE AND ITS DOSIMETRIC SIGNIFICANCE FOR THE TREATMENT OF THE CORPUS CARCINOMA. Vebersik, Vlastimil; Herold, Jan (Charles Univ., Prague). Strahlentherapie; 142: No. 2, 145-50(Aug 1971). (In German).

The author reports on an intrauterine T-shaped probe for the

treatment of corpus carcinomas. The probe consists of polyvinylchloride and can be easily manufactured at any working-place. Shaped like a straight probe when introduced, it thereafter can be easily formed into the required T-shape in order to fill and irradiate the cavum and the fundus uteri. For the purpose of determinating the average dose for the cavum and the fundus uteri, the point C was established 4 cm above the point A, at the same axial distance from the cervical canal. The dosimetry of the T-probe was completed by isodose values and x-ray film of normal and pathological applications. The dose distribution was verified by the photographic valuation of the autoradiograms of the probe. At the end, questions of homogeneity and of dose distribution for irradiations with T-probes and for the packing method, of the professional radiation exposure with the two methods, and of the economy arguing in favor of the T-probe are discussed. (auth)

12397 SERIAL PULMONARY PERFUSION SCANNING IN RADIATION THERAPY FOR BRONCHOGENIC CARCINOMA. McCormack, Kenneth R.; Cantril, Simeon T.; Kamenetsky, Stephen (Mount Zion Hospital and Medical Center, San Francisco). J. Nucl. Med.; 12: No. 12, 800-3(Dec 1971).

A group of patients referred for radiation therapy for inoperable bronchogenic carcinoma were studied by serial scanning techniques to ascertain whether the change in the perfusion scan pattern might be a useful guide in predicting the effectiveness of radiation therapy in this disease. Of the 27 patients in the series there were 12 who showed an improvement in the perfusion pattern following radiotherapy, six who showed no change, and nine who showed a decreased perfusion in the involved area. The serial lung scans did not help to predict the future clinical course in this group of patients. (C.H.)

12398 METHODS CONCERNING THE PERCUTANEOUS RADIOTHERAPY OF THE CARCINOMA OF THE PROSTATE. Schmidt-Hermes, Heinz-Josef; Sommer, Franz; Kopper, Juergen (Univ., Homburg, Ger.). Strahlentherapie; 142: No. 2, 141-4 (Aug 1971). (In German).

The importance of megavoltage therapy in carcinoma of the prostate as well as its results are discussed in reference to the current American literature. A new method of radiation by photons of a kinetic energy of 42 MeV is described, which preserves the paraprostatic tissue and the rectum even if high focal doses are applied. In addition, the authors describe a method concerning the electron-pendulum-irradiation and refer to the possibility of a photon-pendulum-irradiation as well as to a cineroentgenotherapy with ^{60}Co. (auth)

12399 USE OF PARTICLE ACCELERATORS IN MEDICINE. Leboutet, H. (Thomson-CSF, Domaine de Corbeville, Orsay, France). Rev. Gen. Elec.; No. Special, 101-12(May 1971). (In French).

Various factors associated with the use of radiations in medicine are considered: biological effectiveness, depth distribution within the body, the extent of the region exposed, the uniformity of the beam, and the sharpness of the edges. Problems concerning the production of neutrons, the use of heavy ions, π mesons, and short lives isotopes are reviewed. The operation of particle accelerators for medical use is analyzed. (France)

12400 EXTERNAL VS. INTERSTITIAL IRRADIATION IN UNRESECTABLE RECURRENT CANCER OF THE CERVIX. Evans, S. R. Jr.; Hilaris, Basil S.; Barber, Hugh R. K. (Memorial Hospital, New York). Cancer; 28: No. 5, 1284-8(Nov 1971). (CONF-710529-4).

From twenty-fourth annual scientific session of the James Ewing Society; Portland, Oreg. (6 May 1971).

One-hundred and fourteen patients were explored and found to have unresectable recurrent carcinoma of the cervix. Forty-four patients were unsuitable for further treatment. Seventy patients were treated with a combination of interstitial γ implantation and/or external megavoltage x irradiation. All of the patients in the untreated group died within 15 months. In the treated group, 10% of the patients lived 15 months or longer, and 6.2% (4 patients) survived 5 years or more. Interstitial and external radiation therapy provide, therefore, temporary relief of disabling signs and symptoms and an occasional long-term survivor. (auth)

12401 IRRADIATION OF IN-SITU AND INVASIVE SQUAMOUS CELL CARCINOMAS OF THE VAGINA. Brown, George R.; Fletcher, Gilbert H.; Rutledge, Felix N. (M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). Cancer; 28: No. 5, 1278-83 (Nov 1971). (CONF-710529-3).

From twenty-fourth annual scientific session of the James Ewing Society; Portland, Oreg. (6 May 1971).

Between 1948 and 1967, 34 in-situ carcinomas and 76 invasive squamous cell carcinomas of the vagina were treated by irradiation. The results of treatment are analyzed separately for the in-situ carcinomas and the invasive squamous carcinomas according to the classification of the International Federation of Gynecology and Obstetrics. The techniques of treatment are described according to the location of the disease, that is vault, vaginal walls, and close to the introitus. The local control and survival rates are excellent in patients with Stage I and Stage II disease, dropping drastically in those patients with Stage III disease. In selected patients with Stage IV disease, 4,000 rads whole pelvis followed by anterior or posterior exenteration may be the treatment of choice. Particular emphasis is given to the natural history of the in-situ carcinomas. A reappraisal of the management of these lesions is discussed, with reference to location, multiplicity, age, and sexual activity of the patients. (auth)

12402 RADIOIODINE THERAPY OF THYROID CANCER. Pochin, E. Eric (University Coll. Hospital Medical School, London). Semin. Nucl. Med.; 1: No. 4, 503-15(Oct 1971).

Radioiodine uptake has been found to develop in over 50%, and probably in about 80%, of all adenocarcinomas of the thyroid, provided that tests are made at times up to four mo or more after total ablation of all normal thyroid tissue. In tumors that have been shown by biopsy to be predominantly or solely papillary in structure, efficient uptake and response to radioiodine therapy occur about as commonly as in those that are mainly or entirely follicular; uptake also develops often in tumors in which colloid is not demonstrable. Hürthle cell carcinomas rarely concentrate radioiodine efficiently or respond to this type of therapy. Once uptake has developed, effective treatment of a disseminated tumor usually requires from three to seven therapeutic doses of 150 mCi of ^{131}I each, given over the course of two to five yr, before all clinical and counting evidence of remaining tumor tissue is abolished. During the course of this treatment, the progress of tumor destruction can be ascertained by quantitative indications of the amount of remaining tumor activity. A simple and comprehensive measure is obtained from the plasma concentration of protein-bound radioiodine as determined at six days after each dose. This value is ordinarily found to fall progressively during the course of effective treatment, and it probably parallels the remaining amount of functioning tumor tissue at the time of each dose. If normal thyroid tissue has been ablated, remaining tumor activity is likely if the value exceeds 0.006%/liter, and certainly if it exceeds 0.010%/liter, but is unlikely with values below 0.003%/liter. Radioiodine treatment may fail because of continuing spread or other complications from existing metastases even if efficient uptake develops, or, occasionally, through development of anaplastic change in the tumor, marrow aplasia, or leukemia. However, ^{131}I therapy appears to be effective in destroying disseminated tumors in about half of all patients treated. (auth)

12403 APPROACH TO DIAGNOSIS AND THERAPY OF THYROID TUMORS. Selenkow, Herbert A.; Karp, Peter J. (Harvard Medical School, Boston. Peter Bent Brigham Hospital, Boston). Semin. Nucl. Med.; 1: No. 4, 461-73(Oct 1971).

An extensive literature concerning the relationship between nontoxic goiter and thyroid cancer has accumulated during the past 25 yr. Considerable diversity of opinion still exists, however, concerning selection of appropriate therapy for patients with thyroid nodules. The controversial nature of this important medical problem is perpetuated by the lack of precise knowledge of the natural history of thyroid cancers and by the limited reports concerning the ability of any particular method of therapy to alter the usually benign course of most thyroid cancers. In the absence of sufficient reliable scientific data upon which to make therapeutic decisions, most investigators have based their recommendations upon analysis of available epidemiologic information derived from large series of patients, ^{131}I scan data, and biopsy data. These general conclusions are reviewed and examined to provide the practicing physician with sufficient empiric information upon which to organize his own thinking concerning management of patients with thyroid nodules. The effectiveness of ^{131}I therapy of thyroid carcinomas is evaluated. (C.H.)

12404 COMPLICATIONS OF RADIOIODINE TREATMENT OF HYPERTHYROIDISM. Becker, David V.; Hurley, James R. (New York Hospital-Cornell Medical Center, N. Y.). Semin. Nucl. Med.; 1: No. 4, 442-60(Oct 1971).

Iodine-131 was introduced for the treatment of hyperthyroidism 25 years ago. It has proved to be effective, inexpensive, and convenient for both the patient and the physician, and it is widely considered to be the treatment of choice for most patients with hyperthyroidism. Several hundred thousand patients have been

treated since the 1940s, and serious complications have been rare. In a small percentage of susceptible individuals, acute radiation effects may lead to mild thyroiditis or an exacerbation of hyperthyroidism. The fear of possible leukemogenesis or carcinogenesis raised by the use of radiation in the treatment of a benign disease led the early workers to restrict the use of ^{131}I therapy for uncomplicated hyperthyroidism to those patients above the age of 45. These fears have been dissipated by time and familiarity, and now many laboratories routinely treat all patients over age 25 with ^{131}I. These younger patients will remain at risk for a longer period, and the possibility of leukemia or thyroid cancer must be reevaluated in terms of this longer period of risk. The possible genetic effects of radioiodine treatment during the childbearing years can probably never be satisfactorily evaluated, yet they remain an issue that cannot be completely ignored in evaluating this form of treatment in younger individuals. Approximately 15 yr passed before the significant incidence of hypothyroidism after radioiodine treatment was fully appreciated. It is now apparent that a regular annual increment of hypothyroidism follows treatment with radioactive iodine. By 10 yr, the incidence of hypothyroidism has reached 50% in some series, and this appears to be the most serious consequence of treatment. Hypothyroidism is easily treated, but it must first be recognized. Its irregular appearance in as many (or as few) as 50% of the radioiodine treated patients presents special epidemiologic problems. (auth)

12405 RADIOIODINE THERAPY OF THE AUTONOMOUS FUNCTIONING THYROID. Miller, J. Martin (Henry Ford Hospital, Detroit). Semin. Nucl. Med.; 1: No. 4, 432-41(Oct 1971).

Radioiodine can be used to destroy thyroid tissue functioning autonomously either as a dominant tumor nodule or as a multinodular goiter with multiple active areas. The required dose of ^{131}I is considerably larger than that used in treating the hyperplastic tissue of Graves' disease, and the results are less predictable. If neither of the above are contraindications in a particular patient, the results with radioiodine can be considered satisfactory. It is probable that some of the delay and most of the uncertainty of the single-dose results could be eliminated by giving still larger doses of ^{131}I. The effects of such large doses of irradiation in these patients are unknown and must await the same careful scrutiny that has been given to the results of the therapy of Graves' disease with radioiodine. (auth)

12406 BETA BLOCKING AGENTS AND ANTITHYROID DRUGS AS ADJUNCTS TO RADIOIODINE THERAPY. Sterling, Kenneth; Hoffenberg, Raymond (Bronx Veterans Administration Hospital, N. Y. Columbia Univ., New York. MRC Clinical Research Centre, Middlesex, Eng.). Semin. Nucl. Med.; 1: No. 4, 422-31(Oct 1971).

Since the major beneficial effects of ^{131}I therapy are often delayed for three to five months or even longer, it is essential to provide more rapid control of thyrotoxic manifestations, particularly in severely ill patients or in those with complications, such as heart failure or psychosis. Three possible regimens have been employed for early management: potassium iodide, antithyroid drugs, and beta-adrenergic receptor blockers. Potassium iodide has been employed after ^{131}I therapy in a few clinics. It is probably sufficient in many cases, but an appreciable proportion of severely hyperthyroid patients are not sufficiently controlled with iodide alone. Therefore, it is preferable to employ other measures. The antithyroid drugs, methimazole and propylthiouracil, are used most widely in this country. Effects of methimazole administered in blocking doses once daily makes such a regimen quite advantageous. Beta-adrenergic receptor blockers have been used increasingly in the last few years. Propranolol has been quite effective in the experience of the authors. In contrast to the conventional antithyroid drugs, propranolol is capable of producing rapid subsidence of many symptoms and signs of thyrotoicosis without affecting tests of thyroid function. The physician can employ this medication as soon as the diagnosis of thyrotoxicosis is strongly suspected, since the drug will not interfere with the usual diagnostic tests. (auth)

12407 TREATMENT OF THYROTOXICOSIS WITH ^{125}I AND ^{131}I. Lewitus, Z.; Lubin, E.; Rechnic, J.; Ben-Porath, M.; Feige, Y. (Beilinson Hospital, Tel-Aviv, Israel. Tel-Aviv Univ., Israel. Soreq Nuclear Research Centre, Tel-Aviv, Israel). Semin. Nucl. Med.; 1: No. 4, 411-21(Oct 1971).

The mode of decay of ^{125}I, which emits in the course of its transmutation cascades of low-energy Auger electrons of a high linear energy transfer (LET), explains its radiobiologic effectiveness in the thyroid gland. The radiation dose delivered to the colloid-cell interphase of the thyroid follicle by disintegration of ^{125}I is about two to four times higher than the dose to this region from the same amount of ^{131}I, when measured and expressed in Rems. At the same time, the cell nucleus receives only about one-third of the radiation delivered to the apical zone, the presumptive site of hormonogenesis in the thyroid follicle. Two years of trial with various methods and doses of ^{125}I have shown that minimal amounts in the range of 1–3 mCi are able to induce a remission of thyrotoxicosis; that the incidence of hypothyroidism seems to be quite low, and partly transient; and that the whole-body exposure is much lower than from ^{131}I treatment. The most promising results have been achieved by the administration of a mixed dose of ^{125}I plus ^{131}I. Some laboratory results suggest that the damage to the apical membrane from ^{125}I stimulates the release of TSH from the hypophysis, and that prophylactic use of thyroid extract during the course of this treatment may be indicated. (auth)

12408 TREATMENT OF DIFFUSE TOXIC GOITER WITH ^{131}I. Dworkin, Howard J. (William Beaumont Hospital, Royal Oak, Mich.). Semin. Nucl. Med.; 1, No. 4, 399-410(Oct 1971).

The effectiveness of the treatment of diffuse toxic goiter with ^{131}I is reviewed. Consideration is given to appropriate selection of patients for radioiodine therapy, as well as to the indications and contraindications for this therapy. Methods of calculating radioiodine dose are presented. It is emphasized that results of therapy cannot be correlated with the method of dose calculation, but, more importantly, they are closely aligned with the amount of radiation actually administered to the thyroid. Recently suggested protocols employing low doses of radioiodine appear to give rise to a lowered incidence of hypothyroidism soon after therapy; however, as is the case with higher doses of radioiodine and surgery, hypothyroidism still appears to increase with time. Since lower doses of radioiodine also are associated with persisting manifestations of the disease, adjunctive drug therapy in the form of propranolol is necessary. The major undesirable long-term effect of radioiodine appears to be hypothyroidism. When radioiodine is used in patients over 20 yr of age, thyroid cancer and leukemia have not appeared as post-therapeutic problems. Because of the unsatisfactory and speculative nature of all forms of therapy for Graves' disease, new approaches are required. The following three-point hypothesis is presented: the thyroid gland is made up of functioning (follicular) cells and stem cells; the functioning cells are long-lived and radioresistant, but Graves' disease and radiation decrease their natural longevity; and the thyroid stem cells are quite sensitive to radiation and differ little from other mammalian stem cells (LD_{37} equal to about 100 to 150 rads). (auth)

Blast and Thermal Effects

Refer also to abstracts 12524, 12544, and 12545.

12409 (DNA-2738-T) BIODYNAMICS OF AIRBLAST. White, Clayton S.; Jones, Robert K.; Damon, Edward G.; Fletcher, E. Royce; Richmond, Donald R. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). 1 Jul 1971. 139p.

After pointing out that accelerative and decelerative events are associated with the direct (pressure) and indirect (translational events including penetrating and nonpenetrating debris and whole-body impact) effects of exposure to blast-induced winds and pressure variations, some of the relevant biophysical parameters are selectively noted and discussed. These included the pressure-time relationship; species differences; ambient pressure effects; the significance of positional (orientational) and geometric (situational) factors as they influence the wave form, the pressure dose, and the biologic response; and data bearing upon the etiology of blast injury. The consequences of pressure-induced, violent implosion of the body wall and the significance of the associated variations in the internal gas and fluid pressures are described and emphasized, including alternating phases of forced hemorrhage and arterial air embolization; fibrin thrombi; coagulation anomalies; and renal, cardiac, and pulmonary sequelae. Tentative biomedical criteria consistent with recent interspecies scaling and modeling studies for assessing primary-blast hazards are presented. (auth)

12410 LIST OF AUTOPSY MATERIALS IN CUSTODY OF THE A-BOMB MEDICAL RECORDS AND SPECIMENS CENTER. II. Fukazawa, Kaichi (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 266-93(1971). (In Japanese).

Autopsy specimens were transferred from ABCC–JNIH Hiroshima Branch Laboratory and Hiroshima Prefectural Hospital to the A-bomb Medical Records and Specimens Center in 1970. These materials are all kept in good condition. This inventory represents autopsy special number, master file number, age at death, age exposed to A-bomb, clinical diagnosis, autopsy materials and tissue slides, and distance from hypocenter at the

time of the Bomb on the 600 specimens autopsied at ABCC–JNIH Hiroshima Branch Laboratory in 1966 and 1967. (auth)

Radiation Effects on Animals

Refer also to abstracts 12257 and 12301.

12411 (LIB/Trans–391) PRELIMINARY RESULTS OF INVESTIGATIONS OF LYMPHOCYTES, FROZEN AND IRRADIATED AT LOW TEMPERATURES. PARTS 1 AND 2. Grillmaier, R. E. Translated by K. E. Cecers (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Biophysik; 7: 120-32(1971). 14p. (LIB/Trans–392). Dep. NTIS (U. S. Sales Only).

Peripheral human lymphocytes were cooled to the temperature of solidification at a rate of less than 1°C/min using glycerol as a protective agent against the effects of freezing. After solidification at temperatures of −10 to −15°C and cooling to about −22°C one group of the samples was thawn and the others were cooled rapidly to −80 or −196°C by immersion into solid carbon dioxide or liquid nitrogen. Other samples of the frozen cell suspension were cooled down to the same temperatures much slower at a cooling rate of 3 to 5°C/min. After rapid thawing in a 25°C water bath the cell suspensions were removed from glycerol and cultured for 24 or 48 h before stopping mitoses by adding colchicine. The samples frozen at −22°C, the samples cooled both rapidly and slowly to −79°C, and the ones cooled slowly to −196°C showed a lower rate of mitosis when colchicine was added after 24 h and a significantly higher rate of mitosis after 48 h of incubation before adding colchicine as compared to the controls (untreated, unfrozen plasma). In the culture frozen rapidly to −196°C no metaphases could be found. The cell concentrations before and after freezing showed no significant differences except those of the culture frozen rapidly to −196°C. The chromosome aberration rate is not significantly increased. Lymphocytes of human blood were frozen at −196°C using glycerol as protective agent against the effects of freezing and irradiated with x-rays up to doses of 4080 R. After thawing and removal of the glycerol the lymphocytes were incubated in the usual way and fixed in the metaphases. The mitotic rate even at high doses is not diminished. At all doses the yield of chromosome aberrations is much lower than that of lymphocytes irradiated at normal temperatures which has been described in the literature. (auth)

12412 (TID–18616(Rev.2)) LABORATORY EXPERIMENTS IN RADIATION BIOLOGY. Shaw, Edward I. (Kansas Univ., Lawrence). Jan 1972. 85p. GPO $1.00.

A set of experiments is presented from which several may be selected for use in radiation biology courses for advanced high school and beginning college students. The experiments demonstrate fundamental principles without requiring extensive or costly specialized equipment. Most of the equipment required is that usually present in the biology, chemistry, and physics laboratories in a high school or small college, with the possible exception of the radiation detection equipment. An attempt was made to keep the experimental design and procedure sufficiently simple so that the student will not lose sight of the goal of the experiment or the principle to be demonstrated. Consequently, these experiments do not require a very advanced knowledge of special aspects of biology or very specialized techniques except in a few cases. (C.H.)

12413 (UR–3490-13) FURTHER STUDIES OF RADIATION-INDUCED INTERPHASE DEATH OF CULTURED MAMMALIAN CELLS. Goldstein, R.; Okada, S. (Rochester Univ., N. Y. School of Medicine and Dentistry). [1970]. Contract AT(30-1)-1286. 21p. Dep. NTIS.

Mouse leukemia cells were labeled with tritiated thymidine and uridine and exposed to x radiation in the stationary and exponential growth phases. It was found that cells irradiated in the stationary phase died more slowly than those irradiated with the same dose in late exponential growth phase. Death of cells irradiated in the stationary phase was accelerated both by the presence of dinitrophenol and puromycin, while that in cells irradiated in the exponential growth phase was stimulated by dinitrophenol, but not by puromycin. The role of enzymatic processes in radioinduced interphase death is discussed. (H.L.W.)

12414 EFFECTS OF CONDITIONED MEDIUM PREPARED WITH DENATURED CELL ON THE LYMPHOCYTE. Kawaguchi, Takayoshi (Wakayama Medical Coll., Japan). Wakayama Med. Rep.; 14: No. 2, 49-52(Sep 1970).

An equivalent percentage of lymphocytes survived in a conditioned medium prepared at lower temperatures as in one prepared at 37°C. Conditioned medium prepared with cells denatured by formalin or by ^{60}Co had the same effect on mouse thymic lymphocytes as a medium prepared with living cells. Addition of bovine serum to the conditioned medium decreased the effectiveness of conditioning. The results indicate that the RPMI 1640 medium is more suitable for growth than RPMI 1640 supplemented with 20% bovine serum, and that the conditioned medium prepared at lower temperatures than 37°C has an identical effect as that prepared at 37°C. The conditioned medium does not contain any positive cell growth factor. Conditioning of the medium by various temperatures and a short cultivation time produce the same effect on the viability of the cells. Formalin denaturation and ^{60}Co irradiation did not change the effect of the medium. Irradiation by 2000 R of ^{60}Co actually seemed to inactivate the cells, because a pH shift downward in the conditioning of the medium was not seen, whereas it was observed if cells were irradiated with less than 1000 R. Addition of bovine serum to the conditioned medium decreased the viability of the cells. It appears that conditioning of the medium may remove cytotoxic substances rather than make nutritional contributions to cell growth. The use of fetal calf serum, or bovine or horse serum conditioned at a lower temperature than 37°C for a short time appears to be most useful for cell culture purposes. (auth)

12415 EFFECTS ON THE SURVIVAL OF HeLa S-3 CELLS OF INDEPENDENT VARIATIONS IN THE SIZES OF THE FIRST AND THE SECOND X-RAY DOSES IN SPLIT DOSE EXPERIMENTS. Malone, J. F.; Foster, C. J.; Orr, J. S.; Solomonides, E. (Western Regional Hospital Board, Glasgow. Glasgow Inst. of Radiotherapeutics). Int. J. Radiat. Biol.; 20: No. 3, 225-31 (1971).

The effect of independent variations of first and second x-ray doses on the magnitude of the initial rise in split-dose x-ray recovery curves was examined. Clear relationships between these doses and the recovery curve rises were obtained. The recovery curve rise may be simply related to the original survival curve shoulder. (auth)

12416 CHROMOSOMAL ABERRATIONS IN THE CELLS OF THIOPHOSPHAMIDE-RESISTANT TUMOR IN RESPONSE TO ALKYLATING AND X-RAY EFFECTS. Voitovitskii, V. K.; Edygenova, A. K.; Kabiev, O. K. (Kazakh Inst. of Oncology and Radiology, Alma-Ata, USSR). Tsitologiya; 13: No. 10, 1272-9(Oct 1971). (In Russian).

Metaphase chromosomal aberrations were studied within 3 days after the treatment with challenge dose of thiophosphamide, sarcolysine, and x rays of two subline cells of rat ovary ascitic hyperdiploid cancer — strain OJ a thiophosphamide-resistant subline used in the experiment, and a parental strain — used in the control. In the control, the total number of cell aberrations exceeded that in the experiment. An average number of aberrations per cell was also higher in the control. In the latter, the share of chromatid and chromosomal lesions related to the total amount of aberrations was reliably more than in the experiment. The results obtained suggest an effective recovery mechanisms in cells of resistant subline, this mechanism being presumably common for different injuries. (auth)

12417 VAVILOV–CHERENKOV RADIATION IN A MEDIUM CONTAINING BIOPOLYMERS. Barenboim, G. M.; Domanskii, A. N. (Inst. of Cytology, Leningrad). Biofizika; 16: No. 2, 181-8(Mar-Apr 1971). (In Russian).

The Vavilov–Cherenkov radiation in biological systems was proved theoretically and experimentally. This radiation is induced by natural radioactivity and is concentrated in the ultraviolet (uv) region. Vavilov–Cherenkov radiation appears in external medium also. This radiation may be considered as one of the concrete mechanisms of action of natural radioactivity on living objects. The uv field in cells is of some interest for the study of such phenomena as mitogenetic radiation, photoreparation, spontaneous mutagenesis, accumulation of natural radioactive isotopes, etc. The role of radiation in radiobiological effects is also taken into account. (auth)

12418 SOME ASPECTS OF RADIATION EFFECTS ON CELL MEMBRANES. Myers, D. K. (Chalk River Nuclear Labs., Ont.). Advan. Biol. Med. Phys.; 13: 219-34(1970).

Irradiation of mammalian cells produces a selective increase in membrane permeability to monovalent cations such as Na^+ and K^+. This effect is linearly related to radiation dose, but the doses required to cause appreciable loss of intracellular K^+ are usually in the range of 10 to 50 krad. As judged by the results obtained with erythrocytes, some form of disorganization of lipoprotein structure must be involved. This results, among other things, in increased susceptibility of the membrane to enzymic attack. Much of this disorganization, which is due in part to oxidation of membrane thiols and in part to other chemical reactions, is repaired

by the erythrocytes at physiological temperatures. Radiation-induced hemolysis depends on Na^+ accumulation and also on a weakening of the membrane by spontaneous formation of lipid peroxides during the postirradiation incubation. Lipid peroxidation is correlated with destruction of lipid antioxidants in the erythrocyte membrane at high radiation doses, by radiation products from the extracellular medium. Lipid peroxidation is not correlated with K^+ loss. The interphase death of thymus lymphocytes following exposure to radiation doses of 0.1 krad or more is associated with a failure of membrane function. However, it is doubtful whether this failure is a direct consequence of radiation damage to the cytoplasmic membrane. In yeast cells, which resemble mammalian cells in that the genetic material is enclosed in a nuclear envelope, damage to the external cytoplasmic membrane by high doses of radiation is associated with an inhibition of metabolic processes in the cell. However, the reproductive survival of yeast cells after irradiation was not markedly influenced by these effects. In bacterial cells, where the DNA is attached to the cytoplasmic membrane, radiation damage to the membrane may have a marked effect on reproductive survival by influencing the repair of radiation damage to the DNA. (auth)

12419 RADIOLOGICAL PHYSICS CHARACTERISTICS OF THE EXTRACTED HEAVY ION BEAMS OF THE BEVATRON. Tobias, C. A.; Lyman, J. T.; Chatterjee, A.; (and others) (Univ. of California, Berkeley). Science; 174: No. 4014, 1131-4(10 Dec 1971).

Studies of the depth-ionization properties and the biological effects of heavy ion beams produced at the bevatron have extended work previously done with less energetic beams from other sources. Results indicate that heavy ion beams are suitable for tumor therapy, studies relating to space biology, and fundamental radiobiology. (auth)

12420 PREDICTION OF THE SPATIAL DISTRIBUTION OF CELL SURVIVAL IN HEAVY ION BEAMS. Vosburgh, Kirby G. (Rutgers–The State Univ., New Brunswick, N. J. Princeton Univ., N. J.). Science; 174: No. 4014, 1125-7(10 Dec 1971).

The possible use of heavy ion beams for biomedical applications was examined through calculations of the physical beam properties and the spatial distribution of cell survival. Range straggling, creation of secondary particles, electron pickup, and the effects of inhomogeneous absorbers were analyzed in terms of cell survival. Depth-survival plots for typical irradiations provide substantial encouragement for the investigation of these beams for biomedical applications in which localized tissue destruction is desired. (auth)

12421 SPATIAL DISTRIBUTION OF BIOLOGICAL EFFECT IN A 3.9-GeV NITROGEN ION BEAM. Todd, Paul (Pennsylvania State Univ., University Park); Schroy, Carter B.; Vosburgh, Kirby G.; Schimmerling, Walter. Science; 174: No. 4014, 1127-8(10 Dec 1971).

A beam of nitrogen ions was used for the irradiation of Chinese hamster (M3-1) cells in monolayer culture. The 3.9-billion-electron-volt (GeV) beam passed along the monolayer, so that ions were stopped in the culture. A sharply defined zone of extensive cell destruction occurred in the last centimeter of the beam path. (auth)

12422 REPAIR OF DNA-SINGLE-STRAND BREAKS IN EHRLICH-CARCINOMA-ASCITES-CELLS DEPENDING ON RADIATION DOSE IN VIVO. Magdon, E.; Schroeder, E. (Institut fuer Krebsforschung, Berlin). Strahlentherapie; 142: No. 2, 195-200(Aug 1971). (In German).

The repair of x-ray-induced single-strand breaks in vivo was studied on Ehrlich-ascites-tumor-cells between 2 and 30 kR. Single-strand breaks were detected by ultracentrifugation in alkaline sucrose gradients. The investigations have shown that the cells are not able to repair x-ray-induced single-strand breaks after a radiation dose of 30 kR. From the results it is concluded that a dose of 30 kR causes inactivation of the enzymatic repair-system of ascites cells. On the other hand, x-ray-induced single-strand breaks after in-vivo-irradiation with 2 kR are not certainly detectable. At a radiation dose of 5 kR a repair-time of 30 min causes a nearly complete recovery of the DNA-properties in the sedimentation analysis. In relation to the calculated molecular weight of the alkaline denatured DNA of 3×10^8 Dalton in the non-irradiated ascites cells a computation was made about the cell-repair-capacity. Consequently Ehrlich-carcinoma-ascites-cells are able to repair one to two single-strand breaks per single-strand molecule with a size of 3×10^8 at a mean number of 2×10^4 DNA molecules per cell on in vivo conditions after 30 min. (auth)

12423 EFFECT OF X RAYS ON HeLa CELLS. Wada, Hiroyuki (Iwate Medical Coll., Morioka, Japan). Iwate Igaku Zasshi; 22: No. 4, 574-84(Oct 1970). (In Japanese).

In order to set up the cytochemical and morphological criteria for radiosensitivity of cultured cancer cells, the effects of x irradiation were studied on HeLa cells using ^{3}H-thymidine (^{3}H-TdR) microautoradiography and Papanicolaou's staining. Trypsinized HeLa cells were incubated in 5% CO_2 in air at 37°C. After 3 days culture, the HeLa cells were irradiated. The cells were divided into four groups on the basis of dose levels (100, 300, 600, and 900 R), and at 24, 48, and 72 hrs after irradiation, the number of cells labeled with ^{3}H-TdR and morphological changes of the irradiated cells were counted. The number of labeled cells among 1,000 irradiated cells was checked after 2-weeks exposure. The number of cells labeled with ^{3}H-TdR decreased at 24 hrs after irradiation in each experimental group. At 72 hrs after irradiation, in the three groups (100, 300, and 600 R), the ^{3}H-TdR uptakes were recovered, but in the 900 R irradiated group no recovery was seen. At 48 hrs after irradiation in the 900 R irradiated group, cytomorphological changes such as polynucleated cells with 10 or more nuclei, nuclei with eight or more nucleoli, and cells with 10 or more micronuclei were observed more frequently than in other groups. The effects of irradiation on the HeLa cells, especially degenerative changes such as polynucleated cells, giant cells, giant nuclei, vacuolization of cytoplasma, caryopyknosis, caryorrhexis, caryolysis, increased nucleoli, and micronuclei were observed in proportion to the dose and the time after irradiation. (auth) (Japan)

12424 COMPUTER ANALYSIS OF THE ROLE OF OXYGEN IN THE MODIFICATION OF RADIOSENSITIVITY OF SELF-RENEWING CELL SYSTEMS. Lerch, Irving A. (Univ. of Chicago Pritzker School of Medicine. Argonne Cancer Research Hospital, Chicago). Radiology; 101: No. 3, 683-93(Dec 1971).

Information obtained by a number of investigators for mammalian cell systems was used as a basis for a computer analysis of the effects produced by assumed oxygen distributions on radiosensitivity in simple two-compartment tissue models. At low exposures, surviving distributions are slightly better oxygenated; as dose increases the distribution shifts in the hypoxic direction. The effects of time and dose on postirradiation changes were studied by a computer program developed to study time-dependent changes in radiosensitivity after an initial conditioning exposure. These data can be of importance in establishing fractionation regimens in radiotherapy. (auth)

12425 MODIFICATION OF RADIOSENSITIVITY BY MYCOPLASMA. Pritchard, J. A. V.; Moore, J. L. (Velindre Hospital, Cardiff, Wales). Int. J. Radiat. Biol.; 20: No. 6, 597-8(1971).

Three strains of HeLa S_3 cells were irradiated with ^{60}Co irradiation and the survival data obtained were analysed by an ICL 1903 computer, using a method of least squares analysis to obtain survival curves. Two of the strains were contaminated with Mycoplasma sp. Oxygen enhancement ratios appeared to be independent of Mycoplasma infection, but the Do values seemed related to the degree of contamination. (UK)

12426 X-RAY INDUCED MORPHOLOGICAL DIFFERENTIATION OF MOUSE NEUROBLASTOMA CELLS IN VITRO. Prasad, K. N. (Univ. of Colorado, Denver). Nature (London); 234: No. 5330, 471-3(24 Dec 1971).

It is stated that although undifferentiated human neuroblastoma cells are known to have high radiosensitivity, the nature of changes induced by irradiation is uncertain. Two possibilities are that the neuroblastoma cells are destroyed, or they are induced to differentiate or mature into ganglioneuroma. Experimental evidence to support the latter has hitherto been lacking, but the availability of mouse neuroblastoma cell culture provided an opportunity to study the subject. The experimental work with such cultures showed that x-irradiation induced morphological differentiation of neuroblastoma cells that in the presence of serum underwent morphological maturation. A description is given of the method used to culture neuroblastoma cells from primary mouse tumor. The cells were x-irradiated 24 hr after plating, using 250 kVp 30 mA radiation at a dose rate of 139 R/min. Either a single dose of 200 to 1,000 R or a fractionated dose of 800 to 1400 R (200 R/day) was employed. The formation of axons was regarded as an expression of morphological differentiation, and enlargement of the nucleus and cell size as indicating morphological maturation. It was also shown that the presence of serum after x-irradiation was necessary for the expression of maturation; also that any irradiation change in serum constituents was not responsible for the irradiation induced morphological differentiation. Recovery of neuroblastoma cells was also studied using a fraction-

ated dose technique. There were indications that the effect of x-irradiation may depend on its promoting the assembly of microtubules. (UK)

12427 INTERACTION OF RADIATIONS OF DIFFERENT LET. Lawson, R. C. (Western Regional Hospital Board, Glasgow). 8p of Symposium on the Use of Cyclotrons in Medicine. London; Medical Research Council (1969).

From Symposium on the use of cyclotrons in medicine; London, England (20 Sep 1969). See CONF-690979.

It is suggested that when two or more irradiations are given simultaneously, the natural logarithm of the resulting survival S, at a given dose, D rads could be expressed as $\ln S = \Sigma_{i=1}^{n}(f_i \ln S_i)$, where S_i is the survival at D rads for radiation i, and f_i is the fraction of dose D due to radiation i. The work of Barendsen and Bewley is discussed in relation to the author's equation. Experiments with neutrons and x rays showed a discrepancy between theoretical curves and the neutron data. Work with simultaneous x ray and alpha irradiation is mentioned, together with the potential usefulness of prediction in the study of survival data for negative pi mesons for which available dose-rates at the time of writing were low. (UK)

12428 CELLULAR MODEL FOR THE STUDY OF THE RECOVERY KINETICS AFTER SINGLE, FRACTIONATED, AND CONTINUOUS IRRADIATION. Dutreix, J.; Lellouch, J.; Wambersie, A. (Institut Gustave Roussy, Villejuif, France). Ann. Phys. Biol. Med.; 5: No. 3, 135-63(1971). (In French).

A model of the animal cell population, which can be used in the study of the recovery from sublethal radioinduced lesions, is presented. In this model the sublethal cell damage occurring during the irradiation is supposed to be random; its distribution in time is also considered to be random. The target concept adopted in the reasoning does not imply any hypothesis on the real biological nature of the sublethal damage. The state of the population is represented by the distribution of the surviving cells as a function of the targets damaged (the degree of sublethal damage); the cell mortality resulting from the accumulation of sublethal damage is calculated. This distribution was studied after a short irradiation, during fractionated irradiation, and during continuous irradiation. The effects of fractionated and continuous irradiation are compared. (France)

Invertebrates

Refer also to abstracts 12231 and 12572.

12429 CHANGES OF THE PUPAL MORPHOGENESIS IN CERATITIS CAPITATA WIED (INSECT, DIPTERA) AFTER γ IRRADIATION IN THE TERMINAL INSTAR STAGE. Cals-Usciati, J. (Univ., Paris). Compt. Rend., Ser. D; 273: No. 1, 79-82 (5 Jul 1971). (In French).

Gamma irradiation of Ceratitis capitata instar larvae in the third stage, 30 hours before the critical period, with doses less than 40 Krads does not have any effect on the apolysis and ecdysis associated with the pupal molt. Although the endocrine control and the morphogenetic movements which result in the phanerocephale pupa remain unaffected, the atrophy of the sheaths corresponding to the imaginal disks demonstrates a particular radiosensitivity in the organs with high mitotic activity. (France)

12430 DEVELOPMENT OF TIPULA IRIDESCENT VIRUS (TIV) IN GALLERIA MELLONELLA LARVAE EXPOSED TO GAMMA RADIATION. Jafri, R. H.; Chaudhry, M. B. (Panjab Univ., Lahore). J. Invertebr. Pathol.; 18: No. 1, 46-50(Jul 1971).

Tipula iridescent virus was inoculated into healthy Galleria mellonella larvae as well as into larvae that received 5, 10, 20, and 50 KR of gamma radiation. Cytopathological studies of larvae exposed to 5 KR showed that most of the tissues were susceptible to TIV attack. The tissues of the larvae receiving 10 KR were not attacked by TIV in the first week following irradiation. However, scattered TIV particles appeared in the midgut (MG) epithelium, circular visceral muscles (CVM), longitudinal visceral muscles (LVM), and skeletal muscles (SKM) in the second week. TIV was not observed in adipose tissues (FB), ventral nerve cord (VNC), Malpighian tubules (MPGT), and tracheal matrix (TRMX) up to the end of the second week. When the radiation dose was increased to 20 KR, there was a change in the susceptibility of irradiated tissues to TIV attack. In the first week, even those tissues that were not infected by TIV in larvae exposed to 10 KR group, such as TRMX, MPGT, and FB, appeared to be infected by scattered TIV particles. The scattered TIV particles in these tissues were rare in the second week. However, the CVM, LVM, SKM, VNC, and hypodermis showed an increased number of TIV particles at the end of second week. The pattern of inhibited development of TIV in 50 KR group was nearly similar to that of the 20 KR group, and in all cases appeared to be correlated with the appearance of vacuoles and spaces in the cells. Perhaps the permeability of the irradiated cells may be a factor in determining the attack of insect viruses on such cells. (auth)

12431 EFFECTS OF IRRADIATED DIETS ON PRODUCTION OF PROGENY BY SEVERAL SUCCESSIVE GENERATIONS OF THE INDIAN-MEAL MOTH, PLODIA INTERPUNCTELLA (HUEBNER). Brower, John H.; Tilton, Elvin W.; Cogburn, Robert R. (Agriculture Research Service, Savannah, Ga.). Contract AT(49-11)-2676. Radiat. Res.; 48: No. 2, 283-90(Nov 1971).

Indian meal moths, Plodia interpunctella, were reared for nine generations on an irradiated whole wheat flour diet or for four generations on irradiated raisins. Diets were treated with dosages of 0, 25, 50, 100, 500, 1000, and 4300 krad of gamma radiation. Each generation was checked for fecundity and for altered sex ratios. No statistically or biologically significant effects on the numbers of progeny or their sex ratio were found. Irradiated flour and raisins appear to be safe as insect culture media. (auth)

12432 DETECTION OF A BIOLOGICAL RESPONSE TO VERY WEAK RADIATIONS. Planel, H.; Soleilhavoup, J. P.; Tixador, R.; Caratero, C. (Univ., Toulouse). pp 336-9 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Paramecium caudatum and Paramecium aurelia cultures were irradiated using ^{60}Co γ sources with dose rates varying between 100 and 600 millirads per year. The cellular growth, measured by counting the populations at regular intervals, was accelerated. The effect of the ambient activity level on cellular growth was demonstrated. (France)

12433 COMPETITIVENESS OF GAMMA-STERILIZED MALES OF THE MEDITERRANEAN FRUIT FLY: EFFECT OF IRRADIATING PUPAL OR ADULT STAGE AND OF IRRADIATING PUPAE IN NITROGEN. Hooper, G. H. S. (International Atomic Energy Agency, Vienna). J. Econ. Entomol.; 64: No. 6, 1364-8(Dec 1971).

The sterilizing effect of 1 to 13 krad of gamma radiation given to 2- to 6-hr-old adults of Ceratitis capitata (Wiedemann) was established. Male sterility increased with increasing dose to reach 98.5% at 9 krad and 99.8% at 13 krad. The relationship between sterility and dose was similar to that found for males irradiated 2 days before eclosion. Above 3 krad, females produced eggs for 1 week, the number decreasing with increasing dose, and they then became infecund. When confined with untreated pairs in a 3:1:1: ratio, males treated with 5,7,9, or 11 krad 2 days before eclosion or as 2- to 6-hr-old adults reduced egg hatch to about the same extent. When males were irradiated in nitrogen 2 days before eclosion the gamma dose had to be increased by approximately 2.5 krad over that required in air to achieve a particular level of sterility. However, at the 98% level of male sterility, irradiation in nitrogen resulted in males which were 3 times more competitive than males irradiated in air. (auth)

12434 STERILIZATION AND COMPETITIVENESS OF THE MEDITERRANEAN FRUIT FLY AFTER IRRADIATION OF PUPAE WITH FAST NEUTRONS. Hooper, G. H. S. (International Atomic Energy Agency, Vienna). J. Econ. Entomol.; 64: No. 6, 1369-72(Dec 1971).

Mature pupae of Ceratitis capitata (Wiedemann) were irradiated with fast neutrons in a swimming-pool reactor, and flies which emerged 24 to 48 hours after irradiation were used in all experiments. The doses absorbed by the pupae were checked biologically with barley seeds and by the $^{32}S(n,p)^{32}P$ reaction. Doses up to 1.9 krad did not adversely affect adult eclosion, and survival at 21 days of males and females was not significantly reduced by 1.9 and 1.1 krad, respectively. Irradiated females became infecund at a dose between 0.7 and 1.1 krad, and 98% sterility in males was achieved with 1.9 krad. Comparison with data for γ-radiation gives an RBE for the fast neutrons of 3 to 4 for female infecundity and 4 to 5 for male sterility. Data from competitive mating experiments comparing irradiation with fast neutrons or γ-radiation suggested that fast neutrons affected male competitiveness less than did γ-radiation. (auth)

12435 RESPONSE OF STRAINS AND SEXES OF THE TOBACCO BUDWORM TO GAMMA IRRADIATION. Wolfenbarger, Dan A.; Guerra, A. A. (Dept. of Agriculture, Brownsville, Tex.). J. Econ. Entomol.; 64: No. 6, 1412-15(Dec 1971).

The doses of ^{60}Co irradiation required to sterilize strains and sexes of Heliothis virescens (F.), were found to vary. A dose of 30 krad caused 97, 75, and 12% reductions in the fertilities of strains which were classed as susceptible, intermediate, and resistant, respectively. Larger doses of irradiation were required to sterilize 24-hr-old adult males than were required to sterilize pupae within 48 hr of emergence; however, adult females were more susceptible than males. (auth)

12436 EFFECT OF GAMMA RADIATIONS ON THE ANT PLAGIOLEPIS PYGMAEA LATR. (FORMICIDAE HYM.) AND TWO OF ITS SOCIAL PARASITES: COMPARISION OF THEIR LIFE SPANS. Passera, Luc (Univ., Toulouse). Compt. Rend., Ser. D; 273: No. 17, 1502-5(27 Oct 1971). (In French).

The resistance of queen Plagiolepis pygmaea and its social parasites Plagiolepis grassei and Plagiolepis xene to γ irradiation was studied in pure and mixed societies. The parasite queens were observed to have a much greater sensitivity. In addition, the presence of P. pygmaea reinforced the resistance of P. xene, but was without effect on P. grassei. (France)

12437 EFFECTS OF SELECTIVE IRRADIATION OF HEMOPOIETIC TISSUE ON THE HEMOGRAM OF MALE IMAGOS OF LOCUSTA MIGRATORIA (ORTHOPTERA). Hoffmann, Jules A. (Univ., Strasbourg). Compt. Rend., Ser. D; 273: No. 18, 1604-7 (3 Nov 1971). (In French).

The reduction in the number of circulating hemocytes after the selective irradiation of hemopoietic tissue of Locusta migratoria demonstrated experimentally the function of this tissue. (France)

Vertebrates

Refer also to abstracts 12211, 12232, 12244–12246, 12248, 12250, 12251, 12261, 12310, 12311, 12349, 12354–12356, and 12360.

12438 (BNWL-1550(Pt.1)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1970 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME I. LIFE SCIENCES. PART 1. BIOLOGICAL SCIENCES. Thompson, R. C. (ed.) (Battelle Pacific Northwest Labs., Richland, Wash.). Oct 1971. Contract AT(45-1)-1830. 129p. Dep. NTIS.

Separate abstracts were prepared for the fifteen sections of this report. (H.L.W.)

For abstracts of individual sections see: 12195, 12196, 12204, 12205, 12252, 12274, 12341, and 12439–12446.

12439 (BNWL-1550(Pt.1), pp 1-16) GASTROINTESTINAL IRRADIATION STUDIES. (Battelle Pacific Northwest Labs., Richland, Wash.).

Progress is reported on the following research projects: glucose, sodium, and fluid absorption and plasma glucose concentration in the x-irradiated rat; mechanism of plasma protein leakage into the intestine of rats, mice, and swine following x and gamma irradiation; movement of chromium-51 in the lymphatic system of rats after abdominal irradiation; cardiovascular response in the irradiated rat; and labeling of the intestinal mucosal cell by intraluminally administered ^{3}H-thymidine. (H.L.W.)

12440 (BNWL-1550(Pt.1), pp 17-18) EFFECTS OF IRRADIATING SKIN. Mahlum, D. D. (Battelle Pacific Northwest Labs., Richland, Wash.).

Development of tumors was studied in rats of the Fischer strain following exposure of the skin to beta radiation from ^{204}Tl plaques. It was found that animals exposed as newborns and weanlings showed a much higher tumor incidence than animals exposed as adults. Male rats showed a higher incidence than females. Tumors from the irradiated animals were transplanted into Fischer and CD strains of rats; growth of the tumors occurred much faster in the Fischer strain than in the CD strain. (H.L.W.)

12441 (BNWL-1550(Pt.1), pp 19-22) RADIATION EFFECTS ON CHYLOMICRON SYNTHESIS AND CAPILLARY PERMEABILITY IN MICE. Hampton, J. C.; Rosario, B. (Battelle Pacific Northwest Labs., Richland, Wash.).

Studies were conducted to determine whether fatty acids in plasma following irradiation are incorporated into chylomicrons or whether they cross the damaged epithelium by diffusion. Mice were given 1500 R x radiation and four days later were given safflower oil by stomach tube. Absorption and transport of lipid were most severely affected in the ileum where epithelial damage was most marked. Ribosomal depletion, cessation of cell proliferation, and impairment of liver function were noted following irradiation. Effects of x radiation on capillary permeability in mice were studied using horseradish peroxidase as a tracer. The distribution of peroxidase was not uniform in x-irradiated animals, although it was uniform in unirradiated mice. Larger vessels, especially the arterioles, were also affected by radiation. (H.L.W.)

12442 (BNWL-1550(Pt.1), pp 35-44) METABOLISM AND EFFECTS OF RADIONUCLIDES IN THE DEVELOPING FETUS AND THE YOUNG. (Battelle Pacific Northwest Labs., Richland, Wash.).

Progress is reported on the following research projects: comparative effects of ^{131}I and x radiation on the rat thyroid; distribution and effects of ^{239}Pu in the fetoplacental unit of the rat; strain differences in the response of the rat to ^{144}Ce; prenatal growth of the rat; development of liver function in the neonatal rat; and effect of biochemical intervention on audiogenic seizure susceptibility induced by prenatal irradiation. (H.L.W.)

12443 (BNWL-1550(Pt.1), pp 45-55) EFFECTS OF RADIOSTRONTIUM IN MINIATURE SWINE. (Battelle Pacific Northwest Labs., Richland, Wash.).

Initiated in 1958, this project seeks to define the biological effect of daily ingestion of ^{90}Sr in miniature swine. Nearly 800 female Pitman–Moore miniature swine, representing three generations, have been exposed to ^{90}Sr at feeding levels ranging from 1 to 3100 μCi/day. About 150 animals with 9 to 12 years of exposure are currently on experiment, not including an additional 40 animals, not part of the main experiment, which are being used for in-depth studies of certain dosimetric, metabolic, and pathologic parameters. The very interesting leukemogenesis studies, which have evolved from this project, are now included in a separate project, Radiation-Induced Leukemogenesis. Dosimetry studies showed that the ^{90}Sr concentrations in the skeletons of offspring of exposed animals agreed with predicted levels. Concentrations were highest at 250 days of age and decreased to the predicted plateau value by 411 days of age. Uterine-milk exposure studies were undertaken to determine the effects of ^{90}Sr exposure at different stages of pre- and postnatal development on the subsequent production of lymphopoietic and hematopoietic disorders. (H.L.W.)

12444 (BNWL-1550(Pt.1), pp 57-63) RADIATION-INDUCED LEUKEMOGENESIS. (Battelle Pacific Northwest Labs., Richland, Wash.).

Cultures of tissues from miniature swine with ^{90}Sr-induced leukemia were prepared and adenoviruses and C type virus particles were isolated from the cultures. Studies were conducted on the effects of ^{90}Sr-induced leukemia filtrate on thymic and spleen cultures from miniature swine; results indicated that the cell division rate was increased in these cultures. Comparative studies on long-term cell cultures from normal and leukemic swine included experiments on the percentage of cells capable of growing from a single cell; chromosome counts; attempts to produce tumors by inoculation of leukemic cells into hamster cheek pouches; and effects of C type virus particles on cultural characteristics of cells from leukemic animals. (H.L.W.)

12445 (BNWL-1550(Pt.1), pp 85-90) INHALATION HAZARDS TO URANIUM MINERS: BIOLOGICAL STUDIES. (Battelle Pacific Northwest Labs., Richland, Wash.).

The biological effects of daily exposures to controlled levels of potentially carcinogenic uranium mine air contaminants in large and small experimental animals were determined. The continuing experiments involve exposure of hamsters and dogs to radon daughters and uranium ore dust. Lifespan studies on hamsters showed that emphysema, fibrosis, hyalinization, and epithelial alterations occurred in lungs of exposed animals. Four groups of beagle dogs were used in experiments on chronic exposure to uranium mine air contaminants and cigarette smoke. The first group was exposed to radon daughters and uranium ore dust; the second to radon daughters, ore dust, and cigarette smoke; the third to cigarette smoke only; the fourth group consisted of control animals. Routine examinations included physical examination, thoracic radiography, hematology, and clinical chemistry. Histological changes in the bronchial epithelium are described and illustrated. The most severe changes were observed in the animals exposed to radon daughters with ore dust and cigarette smoke. (H.L.W.)

12446 (BNWL-1550(Pt.1), pp 91-2) URANIUM MINERS EXFOLIATIVE LUNG CYTOLOGY. Busch, R. H. (Battelle Pacific Northwest Labs., Richland, Wash.).

Techniques for obtaining representative cellular material from the lungs of live dogs are described. The methods include intrabronchial injection and retrieval of saline. Comparisons are made to determine the extent to which actual lung histology is reflected in materials obtained by washing. Cell populations obtained by washing lungs from normal dogs consist primarily of macrophages with a few neutrophils and cellular debris. Washings from a dog with bronchial carcinoma showed large numbers of macrophages, neutrophils, cellular debris, and clumps of malignant cells. (H.L.W.)

12447 (NRC-TT-1498) SOME EFFECTS OF IONIZING RADIATIONS ON THE DIGESTIVE SYSTEM. Ponz Piedrafita, D. F. Translated by D. A. Sinclair (National Research Council of Canada, Ottawa), from Mem. Real Acad. Cienc. Artes Barcelona; 37: No. 16, 519-36(1967). 19p. Dep. NTIS (U. S. Sales Only).

The sequence of the basic steps leading from the absorption of energy to the induction of biological lesions and the principal features of radiation sickness are reviewed briefly, with emphasis on the importance of damage to the digestive system. Special attention was paid to the effects on the active transport capacity and metabolism in the small intestine. Results are reported from experiments using segments of rat intestine in vitro that showed a progressive inhibition of glucose absorption during the first five hours following x irradiation (1200 to 1500 R). After 600 R, an initial decrease (2 to 8 hours) was found, then an increase (24 hours), later a progressive inhibition (96 hours). The effects were the same with total body or abdomen irradiation of rats, but they were not produced when the whole body except for the abdomen was irradiated. Cystamine when injected before irradiation had radioprotective effect. Thirty minutes after in vitro irradiation of everted sacks of jejenum (15 to 20 kR), the active transport of galactose was found to be inhibited, and O_2 uptake of intestinal strips which were irradiated in vitro (10 to 20 kR) was much lower than that of the normal ones three hours following exposure. This respiratory effect did not appear when irradiation was carried out in the presence of cystamine. (auth)

12448 (ORO-3515-7) LONG-TERM STUDY OF SKIN REACTIONS IN MICE BOMBARDED WITH PROTONS AND ALPHA PARTICLES. Lippincott, Stuart W.; Montour, James L.; Wilson, John D.; Rogers, Charles; Bender, Roger (Medical Coll. of Virginia, Richmond, Citadel, Charleston, S. C.). [1971]. Contract AT-(40-1)-3515. 21p. Dep. NTIS.

A total of 2485 C3H male and female mice were bombarded with either protons or alpha particles at energies selected to penetrate 1.04 mm from the former and 0.62 or 1.02 mm in the latter. The bombardment was carried out so that essentially uniform ionization occurred throughout the total volume of tissue irradiated. The range of doses was 5, 25, 50, 100, 250, 500, 1000, 2000, 5000, and 10,000 rad. Of 855 mice that lived beyond one year, only fourteen developed malignant neoplasms at the site of irradiation, with no skin neoplasms appearing anywhere else. All neoplasms were malignant, with one being a carcinosarcoma and the others fibrosarcomas. The striking atypical hyperplasia that occurred as early as about twenty-one days at doses from 1000 rad up never developed into neoplastic lesions. Permanent skin damage resulted primarily from fibrosis of limited thickness at 250 rad and with greater thicknesses at the higher doses. (auth)

12449 COMPARISON OF THE EFFECTS OF ELLAGIC ACID WITH THE EFFECTS OF OTHER HAEMOSTATICAL COMPOUNDS UPON THE POST-TRAUMATIC HAEMORRHAGE IN WHOLE-BODY-IRRADIATED RATS. Klir, P.; Pospisil, J.; Skala, E.; Dienstbier, Z. (Charles Univ., Prague. Central Military Hospital, Prague). Strahlentherapie; 141: No. 6, 712-14(Jun 1971).

During the study of the effects of commercially produced hemostatical compounds and ellagic acid upon the post-traumatic hemorrhage in whole-body irradiated rats (700 rad) and non-irradiated rats, a statistically significant shortening of hemorrhage was obtained with 2.10^{-4}M solution of ellagic acid in comparison to Haemarctin, Dicynone, and Reptilase. (auth)

12450 CHANGES IN THE NUMBER OF GRANULOCYTES AFTER EXTRA-CORPOREAL BLOOD IRRADIATION (ECI) IN RABBITS. Pompidou, A.; Le Go, A.; Le Go, R. (CEN, Fontenay-aux-Roses, France). Compt. Rend. Soc. Biol.; 164: No. 12, 2434-8(1970). (In French).

Extra-corporeal irradiation of the blood in rabbits stimulates an early and intense granulocyte reaction in the peripheral blood. This reaction seems to be due neither to operational stress nor to anticoagulants, nor again to any pyrogenic factors produced in the irradiated serum. The meaning and precise origin of this phenomenon remain to be explained. (France)

12451 EFFECTS OF NEONATAL IRRADIATION AND GENOTYPE ON POSTNATAL GROWTH IN MICE. Nash, D. J. (Colorado State Univ., Fort Collins). Biol. Neonatorum; 18: No. 1-2, 17-28(1971).

Growth of the mammalian organism from birth to maturity is influenced by a number of intrinsic and extrinsic factors. Previous work demonstrated that the body weight response of newborn mice was more affected by irradiation than that of adult animals. The regression of body weight on dosage at 60 days of age following neonatal X-irradiation was −0.017 g/R/mouse for females and −0.021 for males. Similar regressions calculated for mice irradiated at 28 days of age yielded a value of −0.0037 g/R/mouse for both sexes combined. In addition, in both studies it was observed that growth was markedly dependent on the genetic constitution of the individual as well as the level of irradiation. Although the control of growth is known to be strongly influenced by the genotype of an animal, much more work is necessary to ascertain the nature and extent of the genetic factors responsible for the control of body weights and organ weights in the mouse. The present studies were designed to evaluate further the genetic mechanisms governing body weights and organ weights in the mouse and to examine organs for differential responses to neonatal X-irradiation. (auth)

12452 EFFECTS OF MICROBIAL ENVIRONMENT AND ENDOTOXIN TREATMENT ON HEMOPOIETIC REPOPULATION IN SUBLETHALLY IRRADIATED MICE. Jenkins, V. K.; Upton, A. C.; Walburg, H. E. Jr.; Satterfield, L. C. (Oak Ridge National Lab., Tenn.). Tex. Rep. Biol. Med.; 29: No. 2, 217-25(Summer 1971).

Hemopoietic repopulation following sublethal x irradiation was studied by the endogenous spleen colony technique in mice exposed to environmental conditions of different microbial flora and to bacterial endotoxin. Mice, maintained in a conventional mouse colony for at least 2 weeks before irradiation, had greater splenic granulopoiesis than did animals maintained in germ-free isolators or under conditions of rigorous isolation. In mice injected with bacterial endoxin, hemopoietic repopulation was greater, with perhaps a shift toward greater granulopoiesis as compared to controls without endotoxin treatment. Possible mechanisms by which microbial flora and endotoxin influence hemopoiesis are discussed. (auth)

12453 INFLUENCE OF SALINE LOADING OF MICE ON THE POST-IRRADIATION RECOVERY OF THE HEMOPOIETIC CELLS IN VIVO. Pereverzev, A. E. (Inst. of Cytology, Leningrad). Tsitologiya; 13: No. 10, 1308-10(Oct 1971). (In Russian).

X irradiation of $C3H_fPu$ mice was performed by the dose-fractionation method under normal conditions, as well as under conditions of saline loading and saline loading with subsequent maintenance on the standard diet. Under saline loading the repair of radiated hemopoietic cells was disturbed. Both single and fractionation irradiation exerts the same influence on the amount of spleen colonies in mice exposed to saline loading. The colony number with fractionation dose becomes larger than that with equivalent single dose if the saline loading is taken off during the first three days after irradiation. These effects could be explained either by the inhibition of the repair of the sub-lethally damaged cells under saline loading conditions, or by the assumption that no sublethal damage arises at all. (auth)

12454 MORPHOLOGICAL CHANGES IN THE LIVER CAUSED BY EXPERIMENTAL FRACTIONATED LOCAL X RAY IRRADIATION. Kovacs, Laszlo (Academic Research Group for Medical Radiology, Budapest). Orvostudomany; 21: No. 3-4, 403-24 (12 May 1971). (In Hungarian).

Rats were locally (2.5 by 2.5 cm) irradiated with a total of 8000 R on 16 occasions. Animals were killed during various stages of the treatment. The livers were examined histologically. There was exudation around the periportal system, necrosis of the parenchymal cells, and fracturing of the argyrophilic fibers. The amount of enzymes and glycogen decreased. Longer periods after the irradiation showed regenerative effects. However, much and severe damage was permanent. These findings indicate that therapeutic x irradiation may damage the liver, an organ generally regarded as insensitive to radiation. (JPRS)

12455 ROLE OF PEROXIDASE-POSITIVE GLIA IN THE RESPONSE OF THE CENTRAL NERVOUS SYSTEM TO IRRADIATION. Srebro, Z. (Medical Academy, Krakow); Lach, H.; Szirmai, E. J. Inst. Nucl. Eng.; 12: No. 5, 137-9(Sep-Oct 1971).

The brains of x-irradiated and repeatedly uv-irradiated rats and mice show a considerable increase in number of periventricular glial cells containing copious granular material very rich in thiol groups. Electron-microscopically this material is composed of dense bodies showing peroxidase activity. The appearance of the thiol-rich peroxisome-like organelles in the periventricular glial cells during the post-irradiation period is interpreted as a reaction to circulating radiotoxins of organic peroxide type. (auth)

12456 BEHAVIOR OF ACRIDINE ORANGE (A-O) FLUOROCHROME IN CELLULAR ELEMENTS EXPOSED TO IONIZING RADIATIONS. I. RESEARCH IN VITRO. di Maggio, C. (Ospedale Militare Principale, Padua); Favarato, G.; Calzavara, F.; Feltrin, G. P. Minerva Med.; 61: 4032-40(19 Sep 1970). (In Italian).

Rabbits were exposed to whole-body x radiation doses of 50,

150, and 300 R. The animals were sacrificed after 12 hrs, 8 days, and 1 month. The spleen, liver, and lymph nodes were removed and examined for acridine orange behavior. The acridine orange presented a range of colors from pale green to yellow up to orange, and to bright red. This variation was directly proportional to the radiation dose. (J.S.R.)

12457 STATE OF HISTOHEMATIC BARRIERS IN GUINEA PIGS AFTER THE ACTION OF IONIZING RADIATION ON THE ORGANISM. Prakapchuk, A. Ya.; Gryngauz, M. Ya.; Yromenka, S. A.; Korsun, U. F. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 1, 79-81(1971). (In Russian).

Cutaneous permeability with respect to radioactive isotopes of phosphorus, sulfur, and arsenic was studied under certain physiological and pathological conditions of the organism. Sixty-eight guinea pigs were used. Prior to the beginning of the experiments, the animals were subjected to x irradiation with total doses of 500 and 900 rad. Twenty-four to 48 hrs later, the isotopes (in doses of 1.8 millicurie in ointment bases) were applied to shaved skin. It was established that the skin is permeable to these isotopes, the degree of permeability depending on the activity of the isotope, the duration of skin exposure to the action of the isotope, and the type of the ointment base used. The largest accumulation of isotopes in the brain, in diminishing order of radioactivity, were found in the hypophysis, gray matter, cerebellum, medulla oblongata, spinal cord, and white matter. (JPRS)

12458 PREVENTIVE NATURE OF BLOOD SERUM AND PROTEIN FRACTIONS IN IRRADIATED AND IMMUNIZED RABBITS. Pogosyan, M. O. Biol. Zh. Arm.; 24: No. 2, 72-8(Feb 1971). (In Russian).

Rabbits were given an 800 R dose of x radiation, and at various times after irradiation (1, 3, 4, 7, or 11 days) the animals were immunized against typhoid fever. The two indicators of preventive capability were protein content of the blood and PD_{50} (the dose of serum capable of protecting from disease 50% of typhoid-infected mice). Irradiation with 800 R caused parallel lowering of both indicators. Immunization of the rabbits caused a lowering of the albumin content and an increase in the PD_{50}. Data were gathered on selected fractions of blood protein, and the dynamics of the preventive properties of the globulin fractions are discussed. (K.S.W.)

12459 MATURATION RATE OF IRRADIATED RAT RETICULOCYTES DURING THEIR CULTIVATION IN VITRO. Strzhizhovskii, A. D.; Borodkina, A. G.; Galaktionova, G. V. Tsitologiya; 13: No. 10, 1250-5(Oct 1971). (In Russian).

Experiments were performed with reticulocytes from normal rats and those irradiated in doses of 200 to 1500 rads. Samples of blood were taken and cultivated immediately after irradiation (a direct action of radiation on reticulocytes) and after one month, when the descendants of damaged marrow erythroid precursors had migrated into peripheral blood (action on marrow precursors). The results show that the maturation rate of reticulocytes considerably decreases due to a direct action of radiation on the circulating reticulocytes and to the action of radiation on marrow precursors. The erythroid precursor damage persists throughout a large number of cellular generations and lowers the reticulocyte maturation rate much more than a direct action of radiation on reticulocytes. Some problems concerning the mechanism of the phenomena investigated and its connection with the late effects of ionizing radiation are discussed. (auth)

12460 PATHOMORPHOLOGY OF WHOLE-BODY IRRADIATED VIETNAMESE SLACK-BELLIED SWINE. Shaefer, R.; Schmidt, W.; Morczek, A. (Medizinische Akademie, Magdeburg, Ger.). Arch. Exp. Veterinaermed.; 24: 1301-23(1970). (In German).

47 young, sexually mature Vietnamese pot-bellied swine were divided into groups exposed to 300, 400, 500, or 600 R of radiation. The effect of vitamin B_{12} administration on the course of the radiation syndrome was also investigated. The course of the radiation syndrome, the survival rate, and the radiation-induced changes in haematopoiesis were all related to the dose of radiation. Pathologically, the syndrome was characterized by severe, generalized haemorrhagic diathesis and a disappearance of lymphatic tissue from lymph nodes, spleen, and tonsils. In the testicles there was a progressive depopulation of seminiferous tubules. Bacteriological studies revealed septicaemia in several cases, caused mainly by enterococci. Vitamin B_{12} did not affect survival rate nor haematological changes, as was reported in small animals. The Vietnamese pot-bellied breed seems to be suitable for the rapid accomplishment of experiments in radiation biology, because of its small size, low management costs, high fertility, and early sexual maturity. (auth)

12461 EFFECT OF INTRA-TESTICULAR ^{45}Ca INJECTION ON THE STRUCTURE AND FUNCTION OF THE TESTIS IN THE INDIAN DESERT GERBIL, MERIONES HURRIANAE JERDON. Srivastava, P. N.; Ramesharao, A. (Rajasthan Univ., Jaipur, India). Bull. Nat. Inst. Sci. India; No. 36, 59-67(1968).

Contrary to the high radiosensitivity of seminiferous epithelium, the interstitial cells of the adult testes display high radioresistance. The experiment shows that the intratesticular administration of minute dose of radio-calcium (10 μc per testis) in the form of $CaCl_2$ could cause massive destruction of testicular epithelium as well as interstitium. The total testicular necrosis is accompanied by massive infiltration first of leucocytes and then of fibroblasts into the testis which shows considerable reduction in its size and wt. The significant fall in the wt. of vesicular glands and ventral prostates is a clear manifestation of damage and destruction elicited in the Leydig cells. The control testes receiving the same amount of non-radioactive $CaCl_2$ show only a transient change involving rare and random death of epithelial cells, the interstitial cells remaining normal. This shows the profound superiority of radiotoxicity over chemical toxicity of a given substance in a biological system when given in small quantities. (Indian Sci. Abstr.)

12462 SURVIVAL PATTERNS OF MICE AFTER TWO-DOSE AND THREE-DOSE FRACTIONATION REGIMENS. Clement, Jacob J.; Willhoit, Donald G. (Univ. of North Carolina, Chapel Hill). Radiat. Res.; 48: No. 2, 409-17(Nov 1971).

The effect of radiation fractionation on mean survival time (MST) of mice was determined for two- and three-dose fractionation regimens for total exposures of 1300 to 2100 R and fractionation intervals from 2 to 24 hrs. The purpose of the study was to determine the effect of three-dose fractionation regimens on a cell-renewal system, using the survival time of mice as an indication of intestinal crypt cell depletion. Cyclic patterns were observed in the variation of MST as a function of fractionation interval for two- and three-dose regimens. The initial peak in MST, presumably due to repair of sublethal injury, occurred at about 3 hrs in the two-dose regimens and at about 2 hrs in the three-dose regimens. When the interval between the first dose and second dose was fixed and the interval between the second dose and third dose was varied in three-dose fractionation regimens, the variations in MST were consistent with a cell-progression model in which the first dose produces a partially synchronized cell population. (auth)

12463 LONG-TERM EFFECTS OF RADIATION ON THE VASCULARITY OF RAT BONE: QUANTITATIVE MEASUREMENTS WITH A NEW TECHNIQUE. Cutright, Duane E.; Brady, John M. (Walter Reed Army Medical Center, Washington, D. C.). Radiat. Res.; 48: No. 2, 402-8(Nov 1971).

Radiation-induced depression of vascularity in the humerus of 62 rats was measured at 2 and 8 months after irradiation with a 250 kVp x-ray unit. These rats were locally irradiated, and later perfused with a silicone rubber material that contained chromium-51. Marked weight loss of the humerus occurred at 8 months with all exposures above 4000 rads. Vascularity decreased in the irradiated humerus to 28% of the unirradiated bone at 4000 rads 2 months after irradiation. At 8 months after irradiation there was no recovery of vascularity at any of the doses studied (2000, 4000, 6000, 8000, and 10,000 rads). The vascular depression after irradiation appeared to consist of two components, the first comprised approximately 70% of the vasculature and was destroyed above 4000 rads. The second, approximately 30% of the vasculature, was present up to 10,000 rads and 8 months after exposure. (auth)

12464 POSTNATAL RESPONSE OF FOUR ORGANS TO PRENATAL IRRADIATION AS MEASURED BY CHANGES IN NUCLEIC ACIDS AND PROTEIN. Martin, Polly G. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-GEN-242. Radiat. Res.; 48: No. 2, 368-76(Nov 1971).

The effects of radiation 160 R (air), ^{60}Co, 3.3 R/min administered prenatally (day 18) on the postnatal development of the rat were determined through quantitative changes in DNA (cell numbers) in liver, thymus, kidney, and spleen at varying ages from birth to 91 days. All four organs were smaller at all ages in irradiated males due to fewer cells per organ. Cellular concentrations of RNA and protein were equal to controls. Total DNA in both the liver and kidney ranged from 70 to 82% of controls from birth to 30 days of age. At birth the DNA content of the irradiated thymus was 71% of controls, but at day 7 postnatal it had fallen to 42% of controls. After day 7, the irradiated thymuses grew at rates greater than controls. A biphasic response was also seen in the spleen with growth of irradiated spleens exceeding controls to 7 days and controls exceeding irradiated spleens in growth due to hyperplasia to day 30. Beyond day 30 and up to day 91 the rate of

accumulation of total DNA was greater in the four irradiated organs studied than in controls. Possible reasons for growth retardation are discussed. (auth)

12465 IMPLICATION OF BIOAMINES IN THE X-RAY-INDUCED TEMPERATURE RESPONSE OF CATS AND RABBITS. Veninga, T. S. (Univ. of Groningen, Netherlands). Radiat. Res.; 48: No. 2, 358-67(Nov 1971).

The increase in rectal temperature observed after exposure of the head of a cat to 600 R of x rays was prevented by pretreatment of the animal with the specific serotonin depleting agent p-chloromethyl amphetamine. Similarly, the rise in rectal temperature induced in the rabbit by 200 R delivered on the hypothalamic region was shown to be blocked by previous application of either ergotamine or propranolol. Ergotamine itself caused a slight pyrogenic effect, whereas propranolol exerted no influence on the rectal temperature in the concentration employed. On the basis of these findings it seems very likely that in the cat serotonin released by x irradiation plays an intermediate role in the observed temperature response. It is suggested that x-ray-released catecholamines function as mediator substances in the temperature reaction of the rabbit. (auth)

12466 BEHAVIOR OF SWINE LEUKOCYTES IN CULTURE AFTER IN VIVO OR IN VITRO EXPOSURE TO 14 MeV NEUTRONS. McFee, A. F.; Banner, M. W.; Sherrill, Mary N. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Contract AT(40-1)-GEN-242. Radiat. Res.; 48: No. 2, 346-57(Nov 1971).

Samples of swine blood were evaluated immediately following in vivo or in vitro exposure to 14 MeV neutrons. Leukocyte cultures established from these samples were appraised after 0, 24, 48, 72, and 96 hrs in culture on the basis of changes in cell type, viability, DNA synthesis, and mitotic rates, polyploid rates, and nuclear volume distributions. Most of the criteria evaluated did not show major differences that could be attributed to a differential response of the cells to irradiation under the two conditions. The initial neutrophil content, the proportion of lymphocytes in cultures at 72 hrs, and the rate of polyploid expression at this same time were significantly related to the dose level administered. The extent of nuclear volume increase by cells in response to PHA stimulation was suppressed by both irradiation conditions but to a greater extent by in vivo exposure. (auth)

12467 RELATIVE EFFECTIVENESS OF FISSION NEUTRONS FOR MINIATURE PIG PERFORMANCE DECREMENT. George, Robert E.; Chaput, Raymond, L.; Verrelli, David M.; Barron, Edward L. (Defense Atomic Support Agency, Bethesda, Md.). Radiat. Res.; 48: No. 2, 332-45(Nov 1971).

Trained miniature pigs were irradiated in a nuclear reactor-produced neutron field (incident neutron to gamma ratio of 10). Their postirradiation performance was compared to that of pigs irradiated in a gamma-ray field from the same reactor (incident neutron to gamma ratio of 0.06). Dose rate at the midline of the brain was approximately 2000 rads/min; midbrain doses ranged from 1,500 to 36,500 rads. Response of the pigs to supralethal doses from the neutron field notably differed from their response to similar doses from the gamma-ray field. Early performance decrement, early transient incapacitation, and immediate permanent incapacitation occurred following much lower doses from the gamma-ray field than from the neutron field. At doses greater than 11,000 rads, survival times of neutron-irradiated pigs were longer than those of gamma-irradiated pigs. Thus, the gamma rays were markedly more effective than the fission neutrons for producing the severe central nervous system damage manifested by pronounced early performance decrement and death within 48 hrs. The relative effectiveness of the neutron field was 0.23 using the gamma-ray field as the reference radiation and the 50 percentile midbrain dose (ED_{50}) for early performance decrement as the biological end point. (auth)

12468 EFFECT OF GAMMA IRRADIATION ON THE CHICKEN RETINA. Bawa, S. R.; Yashroy, Rakesh C. (Panjab Univ., Chandigarh, India). Radiat. Res.; 48: No. 2, 303-11(Nov 1971).

Chickens were irradiated in the head region with an exposure of 2000 R. The retinas were removed and studied 30 days after irradiation. Phospholipids, proteolipids, ribonucleic acid (RNA), deoxyribonucleic acid (DNA), acid phosphatase, and acetylcholinesterase (AChE) were analyzed biochemically. Phospholipids and alkaline phosphatase showed marked increase whereas acid phosphatase, AChE, RNA, and DNA declined. Histochemically, sudanophilia and glycogen increased appreciably. (auth)

12469 METHODS OF ASSAY OF THE RELATIVE TOXICITY OF CERTAIN BONE-SEEKING RADIONUCLIDES. Gridgeman, N. T. (National Research Council of Canada, Ottawa). Radiat. Res.; 48: No. 2, 291-302(Nov 1971). (NRCC-12203).

Four methods of handling the dose-response relation in the data from the long-term experiment on the effects of certain radioisotopes administered intravenously to dogs at the University of Utah are presented and discussed. The results are cast in terms of the relative biological effectiveness of five radionuclides: ^{226}Ra, ^{239}Pu, ^{90}Sr, ^{228}Ra, and ^{228}Th for the production of bone cancers. One of the methods is based on quantal response (deaths from osteosarcomas), two are based on survival times, and the fourth is a modification of that proposed by Blair (which takes account of the induction period between dosage and the beginning of oncogenesis). There is evidence that Blair's approach has most merit. (auth)

12470 CYTOKINETIC EFFECTS OF REPEATED X IRRADIATION IN VIVO IN THE PRESENCE OF A CIRCADIAN RHYTHM IN MITOTIC ACTIVITY. Gibbs, S. Julian; Casarett, George W. (Univ. of Rochester, N. Y.). Radiat. Res.; 48: No. 2, 265-82 (Nov 1971).

A pronounced circadian rhythm was observed in mitotic indices from cheek pouch epithelium of Chinese hamsters. Interaction of this rhythm with cytokinetic effects of x radiation in single exposures of 100 and 300 R and repeated 100-R exposures at 24-hr intervals was investigated. Thymidine-^{3}H was administered 30 min before single or final radiation exposure. Altered rhythmic mitotic activity persisted with repeated irradiation. Early mitotic inhibition appeared to vary directly with total dose, whether or not it was fractionated. Recovery as indicated by a wave of increased mitotic indices 12–24 hrs postirradiation occurred earlier after each succeeding 100-R exposure and was virtually absent after 300-R single exposure. Proportion of labeled mitosis (PLM) curves indicated 4-hr prolongation of G_2 by both 100- and 300-R single exposure, but only 2 hrs by two and three repeated 100-R exposures. These experiments demonstrated the requirement, imposed by the circadian rhythm, of relating observations to time of day as well as to time after irradiation. (auth)

12471 EFFECT OF X IRRADIATION ON SURVIVAL OF WILD AND LABORATORY RATS. Badr, F. M.; Badr, Ragaa S. (National Research Centre, Cairo). Radiat. Res.; 48: No. 2, 256-64(Nov 1971).

The response of a wild population of rats, Rattus rattus and a laboratory stock of albino rat, Rattus norvegicus, to various doses of x irradiation in terms of survival time and mortality rate was studied. The lethal exposure that kills 50% within 15 days postirradiation was estimated and found to be about 400 and 840 R for wild and laboratory rats, respectively. The LD_{50} (30 days) was found to be less than 400 R for wild rats and equals 775 R for the laboratory rat. The mean survival time was found also to be significantly different between the two populations of rats. The results suggest that the radiosensitivity differences are not mainly of quantitative nature but it does imply differences in the underlying mechanisms leading to the final death of the individual as a result of exposure to x irradiation. The results are also discussed in terms of the available data of mitotic activity of bone marrow cells of the same populations of rats. (auth)

12472 METABOLISM AND EXCRETION OF CYCLIC 3′,5′-ADENOSINEMONOPHOSPHATE IN NORMAL STATE, DURING IRRADIATION, AND TUMORAL GROWTH. Fedorov, N. A.; Abakumova, O. Yu. Tr. Mosk. Obshchest. Ispyt. Prir.; 32: 219-22(1970). (In Russian).

Cyclic 3′,5′-adenosinemonophosphate acts as mediator in the action of the major hormones. With irradiation and malignant growth, substantial changes occur in the metabolism of nucleic acids and nucleotides. The function of the hypothalamus-pituitary-adrenal cortex system is greatly disturbed. In this connection, investigations on the metabolism of 3′,5′-adenosinemonophosphate in malignant growth and irradiation present a great interest. Our investigations revealed a sharp decrease of the level of 3′,5′-adenosinemonophosphate excretion up to 4 to 5 mg and increase after therapeutic irradiation up to 12 to 14 mg (normal value = 26 mg). Exogenous administration of 3′,5′-adenosinemonophosphate—^{32}P to rats caused an increase of ^{32}P excretion with malignant growth, irradiation, and administration of caffeine, which is an inhibitor of specific 3′,5′-adenomonophosphate-phosphodiesterase. (auth)

12473 REGENERATSIYA SLIZISTOI ZHELUDKA PRI OBSHCHEM GAMMA-OBLUCHENII (EKSPERIMENTAL'NYE TSITOKHIMICHESKIE ISSLEDOVANIYA). (Regeneration of the Gastric Mucosa Following Whole-Budy Gamma Irradiation (Experimental Cytochemical Research)). Zufarov, K. A.; Baibekova, E. M. Tashkent; Izdatel'stvo Meditsina UzSSR (1969). 123p.

This monograph treats the experimental results obtained from a study of the gastric mucosa in normal rats and those subjected to ionizing radiation, their post-traumatic regeneration, and re-

generation following exposure to a dose of gamma radiation. Comparisons are made of regenerations of epithelial cells of the stomach and the foregut, the degree of completeness of their restoration, and relations with the associated tissues and structures. Mechanisms of suppression and distortion of the regenerative processes during irradiation are discussed. Contemporary histochemical and cytological techniques are described. (198 references.) (tr-auth)

12474 ACUTE LETHAL RESPONSES OF GOATS AND SHEEP TO BILATERAL OR UNILATERAL WHOLE-BODY IRRADIATION BY GAMMA RAYS AND FISSION NEUTRONS. Edmondson, P. W.; Batchelor, A. L. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol.; 20: No. 3, 269-90(1971).

Man-sized goats were exposed either bilaterally or unilaterally, and sheep, a quarter to a half that size, were exposed bilaterally. Deaths from gut injury occurred, with haemoconcentration and gross injury to some portion of the gastrointestinal tract. Deaths from marrow failure occurred, with thrombocytopoenia, haemorrhage, and leucopoenia, and the consequent bacteraemia was regarded as the major cause of death, except in a minority that died from haemorrhage. The distribution of deaths with time after neutron irradiation was different from that after gamma irradiation. Following bilateral exposure the neutron: gamma RBE for the LD 50/37 was 0.73 for goats and 0.83 for sheep. For death from gut injury, the neutron RBE may be about 1.5. In goats the responses of lymphocytes to gamma and neutron irradiation were the same, but those of polymorphs and platelets were slightly different. The RBE for each of these responses appeared to be similar to that for the LD 50/37. When goats were irradiated unilaterally either with gamma rays or neutrons there was an unexpectedly small alteration in the LD 50/37 and RBE. In decedents and survivors, unilateral irradiation caused the same changes in lymphocyte numbers as did bilateral, but polymorph and platelet counts recovered more rapidly whether the exposure was to neutrons or gamma-rays. Unilateral neutron irradiation was perhaps more effective than bilateral in causing gut injury. The sedatives that had to be used caused a transient polymorphonucleocytosis, but otherwise had no effect on the response to irradiation. (auth)

12475 EFFECT OF IONIZING RADIATION AND RADIOMIMETIC DRUGS: THE BONE MARROW IN RAT. Dunjic, A.; Cuvelier, A-M.; Jovanovic, D.; Linchet, Gh. (Catholic Univ., Louvain, Belgium). Int. J. Radiat. Biol.; 20: No. 3, 245-57 (1971).

The response of rat bone-marrow cells to ionizing radiations and radiomimetic drugs, myleran and endoxan, is described in this study. A special attempt is made to quantify the effects at the cellular level. It was found that endoxan mimics very closely radiation effects on erythropoiesis. Myleran induces a less pronounced but longer depression of erythropoiesis, and its effect is dose dependent, even in a supralethal range of doses. The observed survival curve of bone-marrow cells irradiated in vivo was characterized by the following parameters: D_0 = 89 R, D_q = 53 R and extrapolation number N = 1.8. The same values were observed when myleran or endoxan was used, with the exception of a more pronounced shoulder of the curve derived from data on endoxan-treated rats. Restoration by syngeneic bone-marrow was more successful in myleran-treated animals than in those in which radiation or endoxan was used for inducing the lethal bone-marrow aplasia. (auth)

12476 INDIRECT EFFECT OF RADIATION ON EMBRYONIC MORTALITY. Valentini, Eugene J. (Univ. of Minnesota, Minneapolis); Hahn, Eric W. Int. J. Radiat. Biol.; 20: No. 3, 259-67(1971).

Survival of rat embryos in the right uterine horn irradiated (200 to 400 R) on days 1½ or 4½ of pregnancy was significantly increased by concomitant shielding of the left lower-body quadrant. The data are interpreted as evidence that radiation-induced maternal dysfunction is a significant contributing factor to embryonic mortality observed in rats irradiated during the pre-implantation stage of pregnancy. Possible mechanisms of action are discussed. (auth)

12477 RETARDATION OF CEREBELLAR AND MOTOR DEVELOPMENT BY FOCAL X IRRADIATION DURING INFANCY. Altman, Joseph; Anderson, William J.; Strop, Marguerite (Purdue Univ., Lafayette, Ind.). Physiol. Behav.; 7: No. 2, 143-50 (Aug 1971).

The cerebellum of rats was irradiated daily with 150 R x ray from birth for 2, 4, 6, 8, and 10 days. This led to a proportional decrease in the mature weight of the cerebellum due to interference with the acquisition of cerebellar microneurons. The motor development of these animals was observed from 11 to 30 days in an open field situation. It was also assessed in tests in which the rats had either to climb upon a rod or descend on a rope. The animals exposed to the highest number of doses persisted longer in displaying infantile motor patterns and showed a reduced frequency or duration in the exhibition of various motor skills. They also tended to drag their hindfeet, fell during locomotion and were severely handicapped in climbing. The deficits of the intermediate radiation groups were of a lower magnitude, and the low radiation groups were handicapped only in tasks that depended predominantly on the coordination of the hindlimbs. (auth)

12478 EFFECT OF A DIRECT CURRENT ON THE ACTIVITY OF SYMMETRICAL AREAS OF THE CEREBRAL CORTEX IN IRRADIATED ANIMALS. Medyanyk, I. A. (Kiev State Univ.). Fiziol. Zh. SSSR; 17: No. 1, 26-32(Jan-Feb 1971). (In Russian).

Previous investigations established that radiation tends to disrupt conditioned reflex activity in the symmetrical areas of the cerebral cortex. Shifts in the activity of the cerebral cortex of irradiated dogs under the influence of the anode and cathode of a direct current were studied. Positive symmetrical conditioned food reflexes were developed in animals. The heads of the animals were x-irradiated with total doses of 400 rad. The effect of the direct current anode and cathode on symmetric areas of the cerebral cortex was established before and immediately after irradiation, and then a month after the beginning of the experiments. An analysis of the data obtained revealed that anodization of the cerebral cortex of irradiated animals alleviated the phase disturbance of conditioned reflex activity in the symmetrical areas of the cerebral hemispheres and the parabiotic inhibitions induced by radiation, and hastened the restoration of the functional activities of these areas of the cortex to their initial preradiation level. Cathodization had an effect opposite to that of anodization. (JPRS)

12479 EFFECT OF THE TRANSPLANTATION OF PRESERVED AUTOLOGOUS BONE MARROW ON NERVE REGENERATION IN COMBINED TRAUMA. Zayachkovskii, A. G. (Ternopol Mecical Inst., USSR). Vrach. Delo; No. 5, 119-21 (May 1971). (In Russian).

Rabbits were irradiated with x rays in a dose of 600 R. Immediately after irradiation, neurotomy of the left sciatic nerve was carried out, followed by neurorrhaphy. Twelve or 144 hrs after irradiation, the animals received an intravenous injection of autologous preserved bone marrow in an amount corresponding to 3 to 5×10^5 to 7 nuclear cells. The bone marrow was removed by suction from the femur and tibia and preserved at minus 78° in a 15% solution of dimethylsulfoxide. Transfusion of the bone marrow 12 hrs after irradiation resulted in a higher rate of survival of the animals and produced more effective regeneration, resorption of decay products, neurotization, and myelinization of nerve fibers than transfusion 144 hrs after irradiation. (JPRS)

12480 EFFECTS OF ULTRAVIOLET RAYS ON DNA BIOSYNTHESIS IN MYELOID CELLS. Bogutskii, B. V.; Koval'chuk, S. I. (Inst. of Physical Methods of Treatment and Medical Climatology, Yalta, USSR). Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; 36: No. 1, 52-4(1971). (In Russian).

Since it is known that sunburn may be accompanied by temporary hemolysis, an investigation was performed to check the effects of ultraviolet rays on the hematopoietic tissue in bone marrow. The tests were done on 75 mice that were topically irradiated with a quartz lamp over a 6 cm^2 large depilated skin area on the back, for 1, 2, 10, 30, and 60 min. Bone marrow samples were taken 2, 6, 12, and 24 hrs after irradiation and analyzed for DNA according to the method described. The first histological signs of erythema appeared after a 5 min exposure. Staining intensity, indicative of the intensity of DNA synthesis, increased significantly 6 hrs after exposure and returned to normal within 24 hrs. The same was true of longer exposures, except an exposure of 60 min after which the intensity of staining increased on the 2nd hr, decreased on the 6th hr, and subsequently increased again. Since the rays had a low penetrating power and therefore could not act directly on the bone marrow, it was concluded that the reaction was mediated by a neurohumoral mechanism. Tissue injury caused by ultraviolet rays and the breakdown products circulating in blood stimulate DNA synthesis. However, when the concentration of the breakdown products exceeds a certain level, bone marrow activity is suppressed. (JPRS)

12481 X-RAY INDUCED RESPONSES IN THE OVARIES AND PROGENCY OF C_{57} (BI) ICRC MICE. Batra, B. K.; Kochar, N. K. (CRI, Bombay). Bull. Nat. Inst. Sci. India; No. 36, 126-36(1968).

It was seen that the dose of 300 R brings about partial sterility in the animals, for they do not produce more than one litter each. The ability to produce fertilizable egg terminates at about 21 days after the treatment. No appreciable difference was observed when

the litter size was compared between irradiated and control animals. The study of the ovaries themselves showed that the immediate effect was the degeneration of oocytes. About a month after radiation few normal follicles remained in the gland but there was an increase in anovular follicles. This was followed by the appearance of follicular nests till eventually the ovarian stroma occupied the entire gland. The gland either was completely hyalinized or presented an adenomatous condition. In the progeny, observations on mortality have shown that at 13 days in utero, day of birth and at 21 days, or weaning age, a large percentage of young were eliminated. Besides this, in the irradiated young there was a significant incidence of various types of morphological abnormalities. The effects of radiation on the ovaries are discussed with the view to understand the action on the ova and the response and role of the tissue components of the gland, other than the ova. (Indian Sci. Abstr.)

12482 EFFECT OF THE HOMOTRANSPLANTATION OF BONE MARROW ON INCLUSION OF ^{32}P INTO CELLULAR PROTEINS OF THE LIVER, SPLEEN, AND BONE MARROW IN ACUTE RADIATION SICKNESS. Shamray, A. E. (Scientific Research Inst. of Hematology and Blood Transfusion, Kiev). Vrach. Delo; No. 5, 127-9(May 1971). (In Russian).

Rats were irradiated with x rays in a dose of 800 to 850 R. Twenty four hrs later, homotransplantation of bone marrow was carried out by intravenous injection of 2.6 to 3.9×10^7 myeloid cells. The bone marrow was derived from donor rats. On the 4th, 8th, 13th, 20th, and 30th days after irradiation, ^{32}P in the amount of 0.5 μCi/g was administered intravenously. Thirty min later, the animals were sacrificed and the radioactivity of proteins of the liver, spleen, and bone marrow was determined. The inclusion of ^{32}P in rats that were irradiated, but did not receive a transplantation of bone marrow, was determined similarly on the 4th, 8th, and 13th days after irradiation. Later determinations were not carried out, because animals of this group died on the 12th to 13th day. The animals not treated with bone marrow showed a strong increase, vs nonirradiated controls, in the inclusion of ^{32}P into the proteins of the liver, spleen, and bone marrow on the 4th day after irradiation, followed by a strong decrease below normal on the 8th to 13th day. This was presumably due to partial protein starvation and endogenous protein nutrition in the early stage of radiation sickness, followed by depletion of protein reserves and predominance of protein decomposition over synthesis in the organs studied. Irradiated rats that had received a bone marrow transplantation showed a decrease below normal of ^{32}P inclusion into the proteins of the organs studied on the 4th day, followed by a return to normal on the 8th to 13th day, an increase above normal on the 20th day, and a return to normal on the 30th day. (JPRS)

12483 SPECIES RADIOSENSITIVITY UNDER RADIATION EXPOSURE AT DIFFERENT DOSE RATES. Darenskaya, N. G.; Koznova, L. B. pp 323-7 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France: Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Animals were irradiated with a ^{60}Co γ source (mice, rats, guinea pigs, rabbits, monkeys, dogs, pigs, and donkeys). The radiosensitivities of these animals were compared in terms of survival and the different doses and dose rates received. (TSS) (France)

12484 ELECTROMYOGRAPHIC EXAMINATION OF GUINEA-PIG STRIATED MUSCLES AFTER ^{60}Co IRRADIATION. Faes, M. H. (CEN, Mol, Belgium); Rosselle, N. pp 328-31 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France: Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Six groups of four guinea pigs were irradiated with doses of 200, 400, 800, 1,600, 3,200, and 6,400 R respectively. The animals in the groups irradiated with 3,200 and 6,400 R died; the other animals survived. Epilation was observed with the animals irradiated with 3,200 and 1,600 R. The frequency of involuntary contractions of striated muscles observed was proportional to the dose received; their appearance in the first few days after irradiation indicated a large dose to the muscle. (TSS) (France)

12485 RBE OF 34-MeV ELECTRONS COMPARED TO ^{60}Co FOR INTESTINAL DEATH IN MICE AFTER SINGLE AND FRACTIONATED IRRADIATION. DOSIMETRY BASED ON $FeSO_4$. Wambersie, A.; Prignot, M.; Van Dam, J.; Dardenne, J. C.; Gueulette, J. (Univ., Louvain, Belg.). Strahlentherapie; 142: No. 2, 185-94(Aug 1971). (In German).

The Relative Biological Effectiveness (RBE) of 34 MeV electrons compared to ^{60}Co was determined for intestinal death in mice after single and fractionated irradiation. The dosimetry was based on $FeSO_4$, assuming that the response of this detector does not vary as a function of the radiation quality (G = 15.5 for both ^{60}Co and 34 MeV electrons). A Baldwin ionization chamber was used as a monitor for the irradiation of the animals. The calibration coefficient of this chamber for 34 MeV electrons (rd in water per reading unit) was determined by comparison with the $FeSO_4$ dosimeter. The absorbed dose in water can be expressed by $D = L \times N \times C_E$ (L = reading of the ionization chamber dosimeter, N = the calibration coefficient in Roentgen of the chamber for ^{60}Co). The calibration coefficient C_E was found to be 0.81 for 34 MeV electrons (mean electron energy at the depth of the detectors was estimated to be 30 MeV). The recombination in the ionization chamber was estimated to be 1% for our dose rate (mean dose rate: 250 rd/min). C_E should then be 0.80 without recombination. As far as the radiobiological experiments are concerned, a first experiment was planned to determine RBE of 34 MeV electrons compared with ^{60}Co for an irradiation in toto given in one session. The observed RBE values were 1.01 ± 0.05; 1.03 ± 0.06 and 1.02 ± 0.06 ($p = 0.05$), respectively, for death at $4\frac{1}{2}$ days, 5 days, and $5\frac{1}{2}$ days. Survival rate was then compared after in toto irradiation with two doses of 600 rd each separated by a variable time interval (0 to 6 hrs). No difference was observed between survival rates obtained for 34 MeV electrons and ^{60}Co. These results suggest that kinetics of early recovery are the same for both radiation qualities. As a conclusion, these experiments tend to confirm that for equal absorbed dose, the biological effects produced by high energy electrons do not differ quantitatively and qualitatively from those produced by high energy photons or ^{60}Co. (auth)

12486 MORPHOLOGICAL CHANGES IN THE LIVER AFTER AN EXPERIMENTAL, FRACTIONATED LOCAL EXPOSURE TO X RAYS. Kovacs, Laszlo (Ungarische Akademie der Wissenschaften, Budapest). Strahlentherapie; 142: No. 2, 227-37(Aug 1971). (In German).

The effects of fractionated local irradiation of the liver with x rays were studied by different histological methods. In the course of the first 15 days after irradiation, necroses and exudates could be detected about the portal fields, and a decrease of the activity of the enzyme and a fragmentation of the argyrophil fibers in the central lobular areas until the 50th to the 100th day. By the 150th day, fibroses, metaplasia of the lobes, regressive, and regenerative changes developed gradually and an irregular, nonhomogenous distribution of the glycogen level and of the activity of the enzymes could be observed. The results indicate that the liver reacts to the irradiation with a relative sensitiveness, although it is endowed with a noticeable intact regenerative power. The damage of the parenchyma is probably the result of a direct radiation injury of the cells. (auth)

12487 CYTOCHEMICAL APPROACHES TO THE STUDY OF GAMMA-RADIATION INJURY TO NERVOUS SYSTEM. RESPONSE OF THE CEREBELLUM OF MICE. Manocha, Sohan L.; Olkowski, Zbigniew (Emory Univ., Atlanta). Strahlentherapie; 142: No. 2, 201-8(Aug 1971).

The cerebellum of mice was studied histochemically after whole-body exposure of mice to gamma radiations of 636 R at a rate of 53 R/min/mouse. The animals were sacrificed at intervals of $\frac{1}{2}$, 2, 4, 8, and 12 hrs after the irradiation procedure. Changes in the activity of certain enzymes show that whole-body radiations lead to a disturbance in the main carbohydrate metabolizing cycles, e.g., Krebs cycle, anaerobic glycolytic pathway, pentose shunt, and glycogen metabolism in the cortical layers of the cerebellum. The Purkinje cells are particularly sensitive in this respect. The activity of hydrolytic enzymes, particularly those associated with the lysosomes, is as much affected by ionizing radiations as are the oxidative enzymes. It is believed that gamma radiations may have resulted in autolytic destruction of the affected host cells because of the damaged lysosomes, thereby releasing an excess quantity of enzymes in the cells. The significance of these observations is discussed. (auth)

12488 EFFECT OF RADIOPHOSPHORUS (^{32}P) ON THYMUS IN SWISS ALBINO MICE. Kumar, Ashok; Srivastava, P. N. (Univ. of Rajasthan, Jaipur, India). Strahlentherapie; 142: No. 2, 209-12(Aug 1971).

Adult, 6-week old, Swiss Albino mice, weighing 25.0 ± 2.0 g, were injected with carrier-free ^{32}P at the dose of 5.0 μCi/g body weight. The animals were autopsied at intervals of 1, 3 days, and 1, 2, 4 weeks after ^{32}P administration. The thymus showed reduction in the population of lymphocytes both in the region of the cortex and medulla. The lymphocytes of the cortical region were more radiosensitive. Maximum depopulation was seen on the third day after ^{32}P administration. Reparation of thymus starts from one week and is more or less complete after two weeks, but it is observed that the thymus again shows depopulation of lymphocytes at four weeks which may be attributed to the late effects of incorporated ^{32}P. (auth)

12489 EXPERIMENTAL STUDIES ABOUT THE INCIDENCE AND COURSE OF EARLY ERYTHEMA OF PIG SKIN. Renner, Kh.; Renner, H. (Univ., Basel). Strahlentherapie; 142: No. 2, 219-26(Aug 1971). (In German).

In three pigs, 99 fields different in shape and size were irradiated with a different dose rate. This series of experiments supplements the ones reported in the literature. While early erythema in man is induced by a dose lower than the threshold dose that causes the main erythema, in pigs, only doses two and a half times higher than the main erythema dose cause early erythema. Whereas the dose rate plays a major role, the dependance upon the size of the fields is surprisingly low. In contrast to the human skin, in pigs' skin, the appearance of an early erythema goes along with a severe and usually irreversible necrosis. Using a well defined dose rate, a biphasic early appearing erythema can be observed. (auth)

12490 EFFECT OF X IRRADIATION OF THE EXTERIORIZED JEJUNAL LOOP ON THE MORPHOLOGY AND 5-HYDROXYTRYPTAMINE CONTENT OF THE ENTEROCHROMAFFIN CELLS IN THE MOUSE. Penttilae, Antti; Kormano, Martti (Univ. of Helsinki). Strahlentherapie; 142: No. 2, 238-47(Aug 1971).

The effects of 1000 R and 3000 R x irradiation on the fine structure of the enterochromaffin cells (EC), on their formaldehyde-induced 5-hydroxytryptamine (5HT) fluorescence, and of the 5HT content of the intestine were studied in the exteriorized jejunal loop of the mouse, ½ to 8 days after irradiation. Quantitatively, 1000 R had no essential effect on the 5HT content of the jejunal loop, apart from some increase at the regeneration phase, 8 days after irradiation. After 3000 R, a significant reduction of 5HT content was noted at 4 days; the animals exposed to this high dose did not survive for 8 days. In fluorescence microscopy, the EC density seemed to be slightly reduced at 2 and 4 days after 1000 R, but the cytoplasmic architecture and the fluorescence characteristics of the individual EC were essentially intact. The same was the case after 3000 R within the first 2 days, but at 4 days the latter dose caused disappearance of most EC, leaving only fragmentary fluorescent particles in the totally necrotic jejunal epithelium. The specific enterochromaffin granules of the EC were resistant to irradiation as judged by electron microscopy, 1000 R only infrequently caused slight changes in the granules, and even after 3000 R the EC could always be readily identified by their osmiophilic granules among the totally damaged epithelial cells of the mucosa. However, 3000 R caused destruction of several granules, resulting in fragments and halo formation. It is noteworthy that there were great differences both within and between individual EC in the degree of damage to the enterochromaffin granules. It is concluded that the EC show high resistance to x irradiation typical of highly differentiated postmitotic cells. The 5HT-containing granules of these cells seem to be their most radiation-resistant cellular structures. (auth)

12491 DIFFERING RESPONSES TO RADIATION OF MURINE BONE MARROW STEM CELLS IN RELATION TO THE CELL CYCLE. Chaffey, John T.; Hellman, Samuel (Harvard Medical School, Boston. Joint Center for Radiation Therapy, Boston). Cancer Res.; 31: No. 11, 1613-15(Nov 1971).

The response to x radiation of murine bone marrow stem cells in different portions of the cell cycle has been obtained. Murine bone marrow stem cells were injected into suitable recipients and synchronized in vivo with hydroxyurea. At varying times thereafter, irradiation was given, and surviving stem cells were assayed by the spleen colony technique. There was a 10-fold difference between the maximum survival at 9 hr and minimum survival at 10 hr. For determination of the position of the S (synthetic) phase of the cell cycle, another experiment was performed consisting of a second injection of hydroxyurea instead of radiation. A nearly inverse curve was obtained with a minimum survival at 8 hr. This allowed determination of the S phase of the cell cycle. It thus appears that murine bone marrow stem cells are most resistant in late S and are quite sensitive in the G_2–M phase. (auth)

12492 EFFECT OF AGE AT EXPOSURE TO A SUBLETHAL DOSE OF FAST NEUTRONS ON TUMORIGENESIS IN THE MALE RAT. Castanera, T. J.; Jones, D. C.; Kimeldorf, D. J.; Rosen, V. J. (Naval Radiological Defense Lab., San Francisco). Cancer Res.; 31: No. 11, 1543-9(Nov 1971).

Male rats were irradiated with a single whole-body sublethal dose (215 to 230 rads) of fast neutrons as juveniles (1 month), young adults (3 months), or old adults (21 months of age) and maintained in a duration-of-life study. The extent of tumorigenesis was analyzed with respect to the general types of tumors, the percentage of animals with tumors, and the distribution of tumors among organs within each age group. In no instance did irradiation result in a significant excess of animals with tumors in the oldest group. Radiation was particularly effective in inducing benign epithelial and nonepithelial tumors as well as malignant nonepithelial tumors in the juvenile group and malignant epithelial tumors in the young adult group. The skin, kidneys, and Langerhans's islands in the two younger groups; the lungs in the young adult group; and the breast tissue, bone, thyroid, peripheral nerves, and skeletal muscle in the juvenile group were particularly susceptible to the neoplastic effects of radiation. (auth)

12493 EFFECT OF AGE, FRACTIONATION, AND DOSE ON RADIATION CARCINOGENESIS IN VARIOUS TISSUES OF MICE. Vesselinovitch, S. D.; Simmons, E. L.; Mihailovich, N.; Rao, K. V. N.; Lombard, L. S. (Univ. of Chicago). Cancer Res.; 31: No. 12, 2133-42(Dec 1971).

Mice were exposed postnatally to ionizing radiation for investigation of the role of postnatal age periods, fractionation schedule, and dose on carcinogenesis in various tissues. Starting on the 1st, 15th, or 42nd day of age, four experimental series were exposed to a total dose of 320 R x radiation, delivered in either single or fractionated exposures (4 or 7 days apart), and one series received 480 R in four weekly exposures. Mice were killed at 86 weeks of age, and their tumor response was compared with tumor incidence of control animals sacrificed at the identical age and with that of mice sacrificed at 56 weeks of age or observed to 166th week of life. (TSS) (auth)

12494 FOLLICLE SQUASH PREPARATIONS: USES IN STUDIES OF CELL KINETICS FOLLOWING IRRADIATION. Malkinson, Frederick D.; Griem, Melvin L.; Marianovic, Ruzica (Rush-Presbyterian-St. Luke's Medical Center, Chicago. Argonne Cancer Research Hospital, Chicago). J. Invest. Dermatol.; 57: No. 6, 382-8(Dec 1971).

Investigations in CF_1 mice were undertaken to establish the usefulness of whole hair follicle squash preparations in kinetic studies of anagen matrix cell responses to ionizing radiation. The backs of mice were plucked and ^3HTdR (0.8 uCi/g) was injected intraperitoneally 15 minutes prior to x irradiation. Animals were treated with 100 rads at 45 kV. Skin biopsies were fixed in cold acid alcohol for 24 hours, brought through graded alcohols to water, hydrolyzed in 1N HCl, and transferred to Schiff's reagent overnight. Individual follicles were dissected free and squashed on slides in 45% acetic acid. Autoradiographs were made from squash preparations. Mitotic indices were reduced within 30 minutes after x ray exposure (2.4% in control sites vs 1.8% in irradiated sites) and dropped sharply after two hours (2.2% vs 0.7%). There was essentially complete recovery of the mitotic index within 7 hours after irradiation (2.1% vs 1.7%). The post-radiation G_2 period delay was 1 to 2 hours. Studies of the four individual hair types revealed no significant differences in radiation responses despite substantial differences in the sizes of matrix cell populations. Usefulness of the technique described for kinetics studies of drugs or radiation effects on proliferative cell populations is emphasized. (auth)

12495 EFFECT OF CALCIUM CHROMATE DUST, INFLUENZA VIRUS, AND 100 R WHOLE-BODY X RADIATION ON LUNG TUMOR INCIDENCE IN MICE. Nettesheim, P.; Hanna, M. G. Jr.; Doherty, D. G.; Newell, R. F.; Hellman, A. (Oak Ridge National Lab., Tenn.). J. Nat. Cancer Inst.; 47: No. 5, 1129-38(Nov 1971).

Chronic inhalation exposure of C57BL/6 mice to calcium chromate ($CaCrO_4$) dust resulted in a fourfold increase in pulmonary adenoma incidence. Acute exposure to 100 R whole-body x radiation caused a similar increase in tumor incidence. The effects of the two tumorigenic insults were not additive. PR8 influenza virus infection suppressed spontaneous as well as x-ray- and $CaCrO_4$-induced pulmonary adenoma development. The overall lung adenoma incidence was higher in males than in females. $CaCrO_4$ also induced other pathological changes in the respiratory tract, such as epithelial necrosis and regenerative hyperplasia in the conducting airways, alveolar bronchiolization, alveolar proteinosis, and emphysema-like changes, and suppressed the lymphoma incidence. (auth)

12496 EFFECT OF X-RAYS ON THE DNA CONTENT OF THE NERVE AND GLIAL CELLS OF THE NUCLEUS PARAVENTRICULARIS OF THE RABBIT'S HYPOTHALAMUS. Gelashvili, N. A. Soobshch. Akad. Nauk Gruz. SSR; 64: No. 1, 180-4(Oct 1971). (In Russian).

Single x irradiation with 2000 R of the rabbit's right hemisphere, while sparing the other hemisphere and the whole body, results in an increase of the content of DNA in the neurons, their satellites (oligodendroglia), and ependyma glial cells of the nucleus paraventricularis of the irradiated hypothalamus. (auth)

12497 EFFECT OF EXPOSURE AND EXPOSURE-RATE (γ RADIATION) ON THE BRAIN OF THE PRENATAL RAT. Martin, Polly G. (Univ. of Tennessee, Oak Ridge). Int. J. Radiat. Biol.; 20: No. 6, 547-55(1971).

Pregnant rats were irradiated on day 18 of gestation, (160 R, ^{60}Co, gamma) at exposure-rates of 1, 3 and 47 R/min. Body weights of all irradiated animals were less than controls from day 19 (prenatal) through 63 days of age. Concentrations per cell of RNA and protein in the irradiated were not consistently different from controls. Although the cortex from the irradiated animals weighed less than controls and contained less DNA, RNA and protein (1 > 3 > 47 R/min), no exposure-rate effect was evident. In contrast, the remaining portion of the brain from the irradiated groups exhibited not only partial recovery (1 > 3 > 47 R/min) in total DNA in relation to controls but also exhibited an exposure-rate effect. The controls and 1 R/min group (not different) contained more ($P < 0.01$) DNA than the 3 and 47 R/min groups at day 63. (UK)

12498 EFFECT OF PRE-IRRADIATION OF TRANSPLANTED BONE MARROW CELLS ON THE SURVIVAL OF LETHALLY IRRADIATED RECIPIENT MICE. Proukakis, C. (St. Bartholomew's Hospital, London). Int. J. Radiat. Biol.; 20: No. 6, 541-6(1971).

Mice of two different strains, SAS/4 (non-inbred) and CBA (inbred), were irradiated with potentially lethal doses of 14 MeV electrons and then transplanted with bone marrow cells, from donors of the same strain, which had been pre-irradiated with different doses. The total number of viable stem cells (colony forming units, CFU) injected into the mice of each strain was kept constant. When unirradiated donors were used, 10^7 bone marrow cells were injected into the SAS/4 mice and 5×10^5 bone marrow cells into the CBA mice, within each strain. The 30 day survival was the same irrespective of the radiation dose given to the donors. However, it was higher in the CBA than in the SAS/4 mice. The pre-irradiation of the donor bone marrow did not modify the graft versus host (gvh) reaction in the SAS/4 mice as expressed by mortality, 31–90 days after transplantation. The mortality of the CBA mice, during this time period, was minimal, confirming its criticality as a criterion of gvh reaction. (UK)

12499 ACUTE DEATH OF MICE IRRADIATED WITH PULSED X-RAYS FROM A LINEAR ACCELERATOR. Antoku, Shigetoshi; Takeshita, Kenji (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 63-8(1971). (In Japanese).

The comparative lethal effects on mice of 25 MV pulsed x rays from a linear accelerator and ^{60}Co γ rays were studied. The $LD_{50(30)}$ of mice for pulsed x rays and ^{60}Co γ rays were 809 rads and 902 rads, respectively. According to this biological response, the relative biological effectiveness (RBE) of pulsed x rays to ^{60}Co γ rays was 1.1. The patterns of daily mortality and body weight changes of mice irradiated with pulsed x rays were similar to those irradiated with ^{60}Co γ rays. These facts indicated no qualitative differences in biological effects between pulsed and sustained radiations. However, it is necessary to study dose rate effects in various biological materials, because significant differences were reported for intestinal and cerebral deaths between pulsed and sustained radiations. (auth)

12500 EFFECT OF X RADIATION AND SOME IMMUNODEPRESSANTS ON THE IMMUNO-BIOLOGICAL FEATURES OF AN ORGANISM. Ter-Avetisyan, A. T.; Alaverdyan, M. I. Biol. Zh. Arm.; 24: No. 3, 112-15(Mar 1971). (In Russian).

The combined effects of x radiation, antilymphocytic serum (ALS), thiophosphamide, and trimitan on white rats were studied by administering the materials in different combinations 24 hr after radiation exposure. The gamma globulin fraction of the blood of the animals was lowered, reaching a minimum after 21 days. Post-radiation hypoglobulinemia was especially apparent in the combinations ALS + trimitan, ALS + thiophosphamide, and trimitan + thiophosphamide. (K.S.W.)

12501 EFFECT OF WHOLE-BODY X IRRADIATION ON THE LABILITY AND EXHAUSTION OF ANIMAL HEART. Dzhavadyan, N. S.; Shakhnazaryan, E. L. Biol. Zh. Arm.; 24: No. 5, 92-3(May 1971). (In Russian).

Experiments were conducted on dogs and frogs in order to elucidate the lability and exhaustion potential of the myocardium and the sensitivity of the latter to an electric current at various periods of time following whole-body exposure to x radiation. Heart lability was judged by adaptability to slow and fast rhythmic electric stimulation. Data in the irradiated frogs showed that the change in the functional mobility of the myocardium depended not only on the radiation dose, but also on the post-radiation period. These and similar observed phenomena are discussed. (K.S.W.)

12502 FUNCTIONAL POLARITY OF THE CENTRAL NERVOUS SYSTEM OF IRRADIATED WHITE RATS. Arutyunyan, R. K.; Pogosyan, E. G. Biol. Zh. Arm.; 24: No. 5, 69-72(May 1971). (In Russian).

Shifts in the functional polarity of the central nervous system were investigated in irradiated white rats protected by the galvanic irritation of the brain. Galvanization of the brain was conducted at 2 mA for 20 min through electrodes fastened to the skull and lumbar area of the spine. An an-electrotonic state of the brain predominated in the controls. Radiation doses of 500 R were used on the experimental animals, and functional polarity of the central nervous system was measured at the following elapsed periods (days): 1, 2, 3, 4, 7, 10, 14, 21, 28, 30, 37, and 44. The trend of the polarity indicated that galvanization of the brain induced an effect that was evident not only in the first period of radiation injury, but also during the recovery period. (K.S.W.)

12503 ^{75}Se-SELENOMETHIONINE DISTRIBUTION AND TURNOVER AFTER ACUTE ABDOMINAL IRRADIATION IN RATS. Bouckaert, A. (Lovanium Univ., Kinshasa, Congo); Jovanovic, D. Atomkernenergie; 18: No. 4, 323-6(1971).

Dose-response relationships exist between whole-body selenomethionine turnover and dose of x-irradiation of the abdomen in rats. Irradiation of the abdomen induces in rats a sequence of biochemical events leading to modified handling of selenomethionine by the organism. In liver and kidney, increased selenomethionine uptake occurs 48 to 72 hr after irradiation. The comparison with biochemical investigations suggests that the disturbance observed is related to a general modification of protein metabolism as a part of the reaction of the organism against the radiation injury. (auth)

12504 INSTANCE OF STATISTICAL ANALYSIS ON THE ABNORMAL DEVELOPMENT. Satow, Yukio; Miyabara, Shinichi; Ikeda, Takayoshi; Ueno, Takehisa (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 190-6(1971). (In Japanese).

It was shown that irradiation of pregnant rats with 80 to 150 rad of 14.1 MeV fast neutrons on 7 to 11 days after conception induces malformations of the heart and large vessels in the fetuses. On the other hand, from a view point of statistical research, it is important to analyze the experimental data employing some methods or to draw out proper formula from the experimental data and to know certain rules and the future or direction of the experiment. In this study, some methods were carried out such as regression analysis and variance analysis to examine the relation between the malformed rate of the fetuses and the date or the dose of irradiation, and although the malformations are induced by the synthetic effects of the dose and date of irradiation, the results showed that the malformed rate depends on the date, rather than dose, suggesting the importance of sensitive-periods of the abnormal development. The data already reported indicate that irradiation with the dose of 130 rad of neutrons on 8 days after conception is most effective to induce the cardiovascular anomalies: in other words the irradiation of 130 rad, on 8 days after conception induces high incidence of the anomalies with low incidence of absorption of the embryos. To this data the analysis of the relation between the anomaly and absorption adapting χ^2-test or experimental formula were carried out and some significant differences were shown between anomalous and absorbed rate. (auth)

12505 INJURIES OF GASTRIC MUCOSA CAUSED BY X-IRRADIATION. COMPARISON WITH THE EFFECTS ON INDUCING GASTRIC CARCINOMA IN CF_1 MICE BETWEEN A SINGLE DOSE AND REPEATED DOSES OF 2,000 RADS OF X-RAY. Hirose, Fumio (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 139-65(1971). (In Japanese).

For the purpose of clarifying the process of induction of gastric adenocarcinoma by x irradiation, the gastric region of CF_1 mice was irradiated with a single dose or five doses of 2,000 rads of x ray. These animals were periodically sacrificed up to 210 days after the first irradiation and the histological changes of gastric

mucosa were observed. These histological findings in gastric mucosa were compared between the group irradiated with 2,000 rads (Group I) and the group irradiated with 10,000 rads of x-ray (Group II). The early appearance of severe mucosal atrophy, marked ulceration, intensive and extensive squamous metaplasia of mucosal and glandular epithelium, delayed atypical regeneration of epithelial cells, and atypical epithelial hyperplasia were noted in the glandular stomach of animals exposed to x rays, and then gastric carcinoma developed in the mice sacrificed after 90 days following irradiation in both groups. The incidence of atypical epithelial hyperplasia (precancer) was about 36%, gastric adenocarcinoma 64%, and squamous cell carcinoma of forestomach 9% in the Group I, and the incidence of atypical epithelial hyperplasia was 36%, gastric adenocarcinoma 36%, and squamous cell carcinoma of glandular stomach 27% in the Group II. The atrophy, ulceration, and squamous metaplasia of mucosa was more severe and seen in more extensive area, and the mucosal regeneration was more markedly delayed in Group II than in Group I. These findings suggest that the area convenient for developing adenocarcinoma was markedly narrowed and that for developing squamous cell carcinoma was widened in Group II. The atypical epithelial regeneration is one of the most important findings in the process of inducing gastric adenocarcinoma. Some of the atypical epithelial cells that appeared in the regenerating mucosa of the glandular stomach were considered to have the capability of developing into adenocarcinomas through atypical epithelial hyperplasia. These atypical epithelial cells were markedly destroyed by the next x irradiation and they decreased in number as x irradiation was repeated in Group II. This fact is also considered to be one of the causes of lower incidence of gastric adenocarcinomas in Group II than in Group I. (auth)

12506 CONCURRENCE OF MAMMARY TUMORS AND MAMMOTROPIC PITUITARY TUMORS IN RATS TREATED WITH DIETHYLSTILBESTROL OR RADIATIONS AND IN STOCK RATS. Takizawa, Shoichi; Nishihara, Homi; Kawase, Akira; Yokoro, Kenjiro (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol.; No. 12, 93-105(1971).

Several instances of concurrent development of mammary tumors and mammotropic pituitary tumors in rats treated with either estrogen or radiations are described. Ten female and 4 male W/Fu rats were treated with 2 mg of diethylstilbestrol pellets four times during their life at intervals of 2 or 3 months. Eight female rats that survived more than 386 days developed both multiple mammary adenocarcinomas and mammotropic pituitary tumors. In male rats, removal of the testes was effective in inducing mammary tumors to a lesser extent than in female rats. Constant and characteristic morphology of the estrogen-induced mammary tumors and their full hormone dependence indicated that the carcinogenic action of estrogen was directed toward both the mammary gland and pituitary, and that subsequent increase in mammotropic hormone synthesis and release from the tumorous pituitary contributed to the growth of the mammary tumors. Concurrence of mammotropic pituitary tumors was observed in 60% of the female W/Fu rats with mammary tumors, which were exposed to a single whole-body irradiation with a sublethal dose of ^{60}Co gamma-rays or fast neutrons, within two years after irradiation. In the irradiated male rats, only six out of 25 rats developed mammotropic pituitary tumors without accompanying mammary tumor. Histologically, the majority of the radioinduced mammary tumors were fibroadenomas. In another experiment with 380 rads of x rays, four out of 12 female rats developed mammary tumors besides the mammotropic pituitary tumors in situ or syngeneic pituitary grafts under the kidney subcapsule. The third instance of the concurrence was in the old stock female rats of the Sprague–Dawley strain. Five female rats bore both fibroadenomas of the breast and small mammotropic pituitary tumors at the age of 630 days old. In six male rats of the same age, no mammary tumor but one case of mammotropic pituitary tumor, and functionally stimulated mammary glands in the rest of the animals were observed. Six cases of mammotropic pituitary tumors were induced by localized irradiation over the head with 800 R of x rays. There were no concomitant growths of mammary tumors. Taking these facts into consideration, it is suggested that the interaction of carcinogens and mammary gland cells should take place at the initial stage of mammary tumorigenesis, and that the susceptibility to mammary tumor and mammotropic pituitary tumor is genetically determined. (auth)

12507 EFFECT OF TEMPERATURE ACCLIMATION, X IRRADIATION, AND TAIL AMPUTATION ON INCORPORATION OF LEUCINE-^{14}C INTO HEPATIC PROTEINS OF THE HOUSE LIZARD (HEMIDACTYLUS LESCHENAULTI). Pushpendran, C. K.; Eapen, Jacob (Bhabha Atomic Research Centre, Bombay). Comp. Biochem. Physiol.; 40B: No. 3, 651-6(15 Nov 1971).

Synthesis as well as the turnover of proteins was found to be higher in the liver of lizards acclimated to 37°C than in that of animals acclimated to 24°C. X irradiation and tail amputation enhanced the incorporation of ^{14}C-labeled leucine into proteins. The effect on the rate of incorporation was highest during the first hour after irradiation or amputation. The treatments did not seem to affect the total protein content during the course (150 min) of the experiments. (auth)

12508 STUDY OF THE EFFECT OF IRRADIATION ON LUNG CLEARANCE. Nenot, J. C. (CEA, Fontenay-aux-Roses, France). pp 239-46 of Inhaled Particles III. Vols. I and II. /Walton, W. H. (ed.). Old Woking, Eng.; Unwin Brothers Ltd. (1971). (In French).

From third international symposium on inhaled particles; London, England (14 Sep 1970).

The influence of radiation exposure on lung clearance in rats was studied from a functional point of view. Exposure was delivered in two ways: either external γ exposure at L.D. 50 or internal α exposure with ^{239}Pu aerosols at different concentrations. Three levels of alveolar contamination in α emitters were studied: 1, 0.1, and 0.007 μCi/g of lung. Lung clearance was then tested 10 days after exposure, with ^{59}Fe oxide insoluble particles administered to the animals by inhalation. External exposure did not modify either retention or clearance rate, whereas internal exposure to α particles largely modified clearance kinetics. (auth)

12509 COMPARATIVE CYTOLOGICAL STUDY OF THE EFFECT OF INHALED PLUTONIUM AND SILICA ON THE BEHAVIOR OF THE ALVEOLAR MACROPHAGE. Masse, R. (CEA, Fontenay-aux-Roses, France). pp 247-57 of Inhaled Particles III. Vols. I and II. /Walton, W. H. (ed.). Old Woking, Eng.; Unwin Brothers Ltd. (1971). (In French).

From third international symposium on inhaled particles; London, England (14 Sep 1970).

Comparison of the results of cytological observations and kinetic analysis of lung clearance in rats following the inhalation of ^{239}Pu and silica dusts enabled the part played by the different parameters to be established. Plutonium-239 α particles induced cytotoxic and cytostatic action and inhibited the bronchial excretion of macrophages. Silica dust showed a cytotoxic action, enhanced cellular production, and inhibited the bronchial excretion of macrophages. Plutonium action appeared as a threshold mechanism; below a limiting dose cytological changes were compensated and did not result in any trouble of excretion. The determining factor in the blockage of alveolar clearance seemed to be a trouble of cellular mobilization or motility depending on the cell itself and its environment. (auth)

12510 PULMONARY DISTRIBUTION OF α DOSE FROM $^{239}PuO_2$ AND INDUCTION OF NEOPLASIA IN RATS AND DOGS. Sanders, C. L.; Park, J. F. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. pp 489-97 of Inhaled Particles III. Vols. I and II. /Walton, W. H. (ed.). Old Woking, Eng.; Unwin Brothers Ltd. (1971).

From third international symposium on inhaled particles; London, England (14 Sep 1970).

Of 69, 3 month old Charles River albina female rats transthoracically injected with $^{239}PuO_2$ particles, 16 exhibited focal localization of nearly all the injected PuO_2 in pockets of the lung parenchyma and are the subject of this report on the pathogenesis of induced lung tumors. Work previously carried out on the deposition, retention, translocation, and pathological responses of the dog to inhaled $^{239}PuO_2$ particles is reviewed to illustrate the relationship between dose and lung tumor induction. In the rats $^{239}PuO_2$ was localized in comparatively small pockets of the lung parenchyma bearing out the observations in dogs. In rats, fibrosis was only associated with areas of PuO_2 deposition. Metaplasia was seen early in the experiment, prior to the development of neoplasms, and was seen in all rats with neoplasms. The type of metaplasia and neoplasia in rats and dogs argues strongly for the epithelial, either alveolar or bronchiolar, origin of most of the observed tumors. (UK)

12511 ACTION OF CEPHALIC IRRADIATION ON THE HUMORAL IMMUNIZATION RESPONSE IN ADULT RABBITS. Servant, Paule; Darnil, Alain; Rouif, Jean; Creach, Olivier (CNRS, Paris. Hopital Militaire d'Instruction Percy, Clamart, France). Compt. Rend., Ser. D; 273: No. 13, 1147-58(27 Sep 1971). (In French).

When the head of an adult rabbit is irradiated with a high dose, the circulating antibody response to human albumin injected 24hr after the irradiation is modified. The antibodies are detectable much later than with non-irradiated reference rabbits, although the same concentrations are eventually reached. This fact probably does not arise uniquely from the effect on the circulating

lymphocytes. The effect of the irradiation on the central nervous system might also play an important role. (France)

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Refer also to abstracts 12222, 12247, 12262, 12289, 12372, and 12395.

12512 (BNL-16241) MUTATION THEORY OF CARCINOGENESIS AND RADIATION PROTECTION STANDARDS. Baum, John W. (Brookhaven National Lab., Upton, N. Y.). [1971]. 27p. (CONF-711119-1). Dep. NTIS.

From sixth annual topical symposium on radiation protection standards; Richland, Wash. (2 Nov 1971).

Somatic mutation theory of carcinogenesis is invoked to explain four observations in cancer mortality rates in the Japanese survivors of the atomic bombs at Hiroshima and Nagasaki. The observations were: no excess of leukemia was found in 22,400 children conceived after their parents had been heavily exposed to radiation; no increase in cancer mortality during the first ten years of life was noted for 1,292 children who were exposed as fetuses. These two observations are explained by the supposition that a small fraction of the population is highly genetically predisposed to cancer and normally dies of it during the first ten years of life. Since these persons are destined to die of cancer during early childhood, radiation exposure to the parent's germ cells or to the fetus does not cause an increase in this age group. Absolute increase in cancer mortality rate during 1957-58 increased with age at exposure for persons over 20 years of age. This is attributed to gradual accumulation of mutations during life. This causes the adult organism to gradually increase in sensitivity to natural- and radiation-induced cancer. Dose-effect relations followed a power function of dose, with power generally less than one. Since the population is heterogeneous in sensitivity, dose response curves reflect the response of the most sensitive fractions of the population at low doses. As dose is increased, a gradual shift to response of less sensitive fractions of the population causes the dose effect curves to have progressively smaller slopes at higher doses. These findings indicate that linear extrapolation, which is usually assumed to lead to a conservative estimate of risk, may not be valid for the derivation of radiation protection standards. Instead, power function extrapolations seem more appropriate, at least for estimating risk of carcinogenesis in man. (auth)

12513 PREDICTION OF RADIATION LEUCOPENIA AND ITS PREVENTION. Sawazaki, Chiaki; Ogiwara, Norihiko (Nihon Univ., Tokyo). Sanka To Fujinka; 37: No. 3, 302-6(Mar 1970). (In Japanese).

Variation in leucocyte count accompanying radiation therapy was examined in 47 cases of uterine cervical carcinoma given ^{60}Co γ irradiation. Cases were classified into the following three groups: A (17 cases); Leucocyte count above 3900 during irradiation. B (20 cases); Leucocyte count 3000 to 3900 transitorily (within 4 days), but above 3900 in other periods. C (10 cases); Leucocyte count less than 3000 continuously for 5 days or more. Leucopenia was defined as those with less than 3900, and those with less than 3000 were considered to be in grave condition. Cases showing drastic reduction in leucocytes, observed in the initial $\frac{1}{3}$ of the period during irradiation, were further divided into subgroups from the correlation of leucocyte variation after the end of irradiation and rate of leucocyte increase, applying retrospective result to prospective data. For the decrease of leucocytes for several months after the end of irradiation, examinations were made on all cases showing less than 60,000 bone marrow cells and less than 4500 leucocytes, and cases in C group showing 200,000 to 300,000 bone marrow cells and 5500 leucocytes over a long period of time. From the correlation between the number of leucocytes and bone marrow cells, the retrospective result was found to be applicable for prospective data. Correlation between the increase index obtained by bone marrow function test with Cobalt-Greenpole and the variation in leucocyte number (difference between leucocyte count before irradiation and mean number of leucocyte counts during 3 months after irradiation) was used to set a hypothetical clinically permissible limit value for decrease in leucocytes, and a safety range of increase index for leucocyte count before irradiation. These were taken as the standard for radiotherapy for preventing grave decrease of leucocytes in group C cases. (Japan)

12514 LATE POSTIRRADIATION CHANGES AFTER TREATMENT OF ANGIOMAS IN CHILDREN. Bordzilowska, I.; Luszczienko-Sobczak, N. (Medical Academy, Danzig). Pol. Tyg. Lek.; 26: 55-8(1971). (In Polish).

The results of control studies in 42 people treated in childhood with ionizing radiation because of angioma of skin are presented. The control study was carried out after 7 to 18 yrs in order to estimate the effect of the radiation on the further development of the child. In 14 out of 42 children, that is in 33.5%, permanent changes were found in form of hypoplasia of skeleton, teeth, or of soft tissue in the irradiated area. The authors suppose that the indications for treatment of skin angiomas in children with ionizing radiation should be limited as much as possible. (auth) (NSA of Poland)

12515 THREE AUTOPTIC CASES OF SUDDEN DEATH DURING THE COURSE OF RADIATION THERAPY. Takeda, Yusaku; Kimura, Kazue; Kida, Toshiyuki (Fukushima Medical Coll., Japan). Fukushima Igaku Zasshi; 20: No. 3, 205-11(Jun 1970). (In Japanese).

Three cases of sudden death in the process of radiation therapy were experienced. They were as follows: Case 1. Cancer of the lung (right side); the patient died immediately after receiving a dose of 290 rads of ^{60}Co to the primary lesion. Autopsy showed that the tumor had invaded the right bronchus, also the left bronchus beyond the bifurcation. It is considered that the obstruction of the airway resulted from the transient edema of the tumor caused by the irradiation. Case 2. Cancer of the lung (right side); after 8975 rads of ^{60}Co were given to the tumor during the period of 56 days, the patient died of a large amount of violent haemoptysis. In this case, it is considered that a large dose was delivered to the tumor in a relatively short period, therefore, the destruction of the irradiated tumor exceeded the recovery of the surrounding lung tissue. Case 3. Cancer of the esophagus; after a tumor dose of 2027 rads of ^{60}Co was given to the primary lesion for 20 days and then 6 Mvp x ray at 1465 rads for 11 days, the patient died of a heavy haematemesis. In this case, the perforation of the lesion of the esophagus into the aorta was confirmed by autopsy. Of course, this accident might be due to the perforation of the advanced cancer of the esophagus mainly, besides the mixed infection of the lesion and atherosclerotic changes of the aorta must be considered as its cause. (Japan)

12516 INFLUENCE OF OSSEOUS CHANGE BY RADIATION ON THE ACCUMULATION OF BONE SEARCHING RADIONUCLIDES. A REPORT CONCERNING DIFFERENTIAL DIAGNOSIS. Kolar, Jaromir; Babicky, Arnost; Bek, Vaclav; Bibr, Bedrich; Drugova, Bela (Univ., Prague. Isotope Laboratory, Prague). Strahlentherapie; 142: No. 1, 44-51(Jul 1971). (In German).

Different changes are produced in the bone tissue by irradiation that influence the accumulation of bone searching isotopes. One finds different results in literature on increased as well as decreased accumulations around the concerned areas. Both possibilities were confirmed by the present results. The course of the radiogenic osseous changes is decisive. In simple atrophying changes, normal or decreased accumulation levels are found, in infected radiation-induced necrosis, and in new or healing fatigue fractures an increased accumulation level is observed. In old pseudoarthroses normal or decreased levels are measured as an expression of repressed osteogenetic activity. One also finds these differences in animal experiments that underline the correctness of the clinical interpretation of these findings. A critical analysis of the isotope findings and the correlation with other examinations, especially with the x-ray examination, are necessary because of possible mistakes that these deviations could be misinterpreted as metastases and would therefore be exposed to additional irradiation. (auth)

12517 RADIO-INDUCED PNEUMONITIS AND FIBROSIS OF THE LUNG PARENCHYMA AFTER RADIATION OF BRONCHIAL CARCINOMAS. EXAMINATIONS ABOUT FREQUENCE AND ONSET OF THESE DISEASES. A COMPARISON OF DIFFERENT DOSES, RHYTHM OF FRACTIONATION, AND SIZE OF RADIATED LUNG VOLUMINA. Mateev, B.; Eichhorn, H.-J.; Welker, K. (Robert-Roessle-Klinik, Berlin). Strahlentherapie; 142: No. 1, 1-12(Jul 1971). (In German).

172 patients suffering from morphologically certified bronchial carcinoma were subjected to ^{60}Co teletherapy. Examinations were carried out about the influence of different doses, rhythm of fractionation, and radiated lung volume on the frequency and onset of radiation-induced pneumonitis and fibrosis. The following criteria were applied to each case: Minimal survival time of 5 months after radiation therapy; regular x-ray pictures before, during, and after radiation; documentation of the irradiation field by control pictures with the radiation unit in each single case; exact measurement of the whole dose distribution by automatic calculation machine in each single case. The following methods were compared: daily irradiation with low single doses (ca. 250 R TD, 53 patients); daily irradiation with 240 to 270 R TD, interruption of 3 weeks after half of the series, thereafter continuation of daily irradiation with ca. 200 R TD (split technique), 30 patients; 5 daily irradiation with 500 to 600 R TD, 60 patients (the total tumor doses in these series

was always 6000 to 8000 R); daily irradiation with low single doses (250 R TD, 29 patients), until the half total doses of the other series was reached. It is concluded that different single doses and rhythms of fraction have no influence, at least with radiological methods, on the frequency and onset of radiation-induced pneumonitis and lung fibrosis. Of great importance, however, are the dose level and the volume of the irradiated lung area. Independent of single doses and rhythm of fractionation, radiation-induced fibrosis can be found in about 35% by radiological methods. This applies to a total focal dose of 6000 to 8000 R for a volume of $6 \times 6 \times 13$ cm (pendulum radiation). In 25% of all cases, a radiation-induced fibrosis was observed at a volume of $12 \times 15 \times 18$ cm (fixed field irradiation). At a total tumor dose of 3500 to 4000 R, radiation-induced lung fibrosis was observed in only 20% despite the large size of the radiation field ($12 \times 15 \times 18$ cm). Radiation-induced pneumonitis was observed in all cases within the 2nd and 3rd month, the radiation-induced lung fibrosis was observed later than in the 5th and 6th month. (auth)

12518 STUDY OF BRAIN BIOELECTRICAL ACTIVITY IN PERSONS EXPOSED TO CHRONIC IONIZING RADIATION. Sosnovskaya, F. M. (Inst. of Industrial Hygiene and Occupational Diseases, Moscow). Zh. Nevropatol. Psikhiat.; No. 2, 205-9 (1971). (In Russian).

Analysis of the EEG's of 78 persons occupationally exposed to ionizing radiation for 5 to 20 yrs (total doses ranged from 50 to 400 Rem) failed to reveal any gross functional impairment of the CNS in the great majority. The group as a whole exhibited a decrease in alpha activity and intensification of slow oscillations in varying degrees (pathological slow oscillations were found in 16% of the cases). Diffuse acute low-amplitude waves were observed in one-third of the EEG's. There was also a tendency for the background activity to shift to the rapid frequencies. The changes clearly intensified in relation to the total dose of radiation received and the presence of clinical symptoms of radiation sickness (Neurocirculatory dystonia, asthenic and neurotic symptoms) (JPRS)

12519 CANCER OF THE VULVA AFTER RADIATION TREATMENT OF GYNECOLOGICAL MALIGNANCIES. Manka, I.; Belohorsky, B. (Cancer Inst., Bratislava). Cesk. Gynekol.; 36: No. 4, 242-3(May 1971). (In Slovak).

Seven female patients who were earlier treated with radiation for cancer in the reproductive system subsequently showed lesions in the vulva. In four cases these were metastases, but in the other three the malignancy appeared to be due to the irradiation. The evidence was the macroscopic appearance of the growth, its histological composition, and the latent period of appearance of the growth—11, 14, 17 yrs, respectively. The radiation dose was 4500 R. (TTT)

12520 LEUKEMIA IN OFFSPRING OF ATOMIC BOMB SURVIVORS. Hoshino, Takashi; Kato, Hiroo; Finch, S. C.; Hrubec, Z. (Atomic Bomb Casualty Commission, Hiroshima). Hiroshima Igaku; 23: No. 7, 536-43(Jul 1970). (In Japanese).

This report is the result of examinations on all the offsprings (F_1) registered at the Atomic Bomb Casualties Commission (ABCC) used as a basis for sampling the death rate of offsprings from atomic bomb survivors and samples used for examination of the death rate of F_1 from atomic bomb survivors, carried out by the joint venture of the National Institute of Health, Tokyo, and ABCC. The subjects were children born between 1946 and 1963. The subjects were divided into Groups 1 and 2 according to the distance from the bomb center of less than 2,000 m and more than 2,000 m when one or both parents were exposed to atomic bomb radiation. Group 3 consisted of children born of those not exposed to atomic bomb radiation. Incidence of leukemia among these children of atomic bomb survivors in Hiroshima and Nagasaki did not show any significant increase. Children with leukemia, born of parents previously irradiated did not show any abnormality in the period from exposure of the parent to appearance of the disease in children, or the age at the time of appearance of disease or in the type of leukemia. The fact that the effect of atomic bomb radiation was not found in these children does not signify that there was no such effect, and simply shows that such an effect was not detected within the range of observation. Possibility of increased leukemia requires long-term observation on F_1 and subsequent generations. (Japan)

12521 SIGNIFICANCE OF MELANOTIC SKIN PIGMENTATION IN RADIOTHERAPY. Traversin, E. Quad. Radiol.; 35: 73-9 (Jan-Feb 1970). (In Italian).

Some considerations on the cutaneous pigmentation from rays and particularly from ionogenic radiation are presented. This pigmentation has no function of defense from the ionogenic radiation. Any mechanism, leading to an erythema, provokes as epiphenomenon, a melanotical cutaneous pigmentation. (auth)

12522 PATHOLOGY OF RADIATION-INDUCED SIALADENITIS. Seifert, G.; Geier, W. (Univ., Hamburg). Z. Laryngol., Rhinol., Otol.; 50: 376-88(May 1971). (In German).

The history of radiation sialadenitis was analyzed in 115 surgically resected salivary glands (19 parotids, 68 submandibular, 10 sublingual, and 18 small salivary glands). The salivary glands were obtained from 92 patients with malignant tumors of the oral cavity and the face. The dose of radiation was 1800 to 34,700 R (x-ray, telecobalt, betatron): the average duration was 3 to 6 months. The following results were obtained. There was no direct relation between the dose of radiation and the changes in the glands. The sensitivity of individual salivary glands to radiation depends on the structure of the glandular tissues. The cytotoxic effects of the rays occur mostly in the highly differentiated serous acini (swelling, loss of granules, necrosis, atrophy). Multiple factors play a part in the pathogenesis (membrane damage, electrolyte and pH shifts, enzyme changes, vasculitis). These factors result in the loss of parenchyma, reduction and changes in viscosity of the saliva, enzymic disturbances, and reduction of blood supply to the glands. Bacterial gland infections are also regarded as sequelae. The pathological characteristics of radiation sialadenitis are a partial atrophy of the mucous parts of the gland as a result of destruction of serous acini, duct changes (thick secretions, goblet cell and squamous metaplasia, ectasia, and regenerations), and interstitial inflammatory reactions (cell infiltrates, vasulitis, fibrous tissue increase). In the final stages the salivary glands undergo fibrosis or lipomatous atrophy. Clinical side effects are manifest as a dry mouth, stomatitis, dental caries, pain, and other symptoms. (auth)

12523 CASE OF CHRONIC MYELOID LEUKAEMIA IN A PATIENT PREVIOUSLY TREATED WITH RADIOTHERAPY FOR LOCALIZED RETICULUM CELL SARCOMA. Jones, C. T. A. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol.; 44: No. 526, 801-2(Oct 1971).

A case is described of a patient who was treated by radiotherapy for localized reticulum cell sarcoma with complete resolution, and who developed chronic myeloid leukemia two years after a tumor dose of 3000 rads of 4 MV therapy delivered in 16 fractions over 21 days. (auth)

12524 STUDIES OF THE ACUTE EFFECTS OF THE ATOMIC BOMBS. Key, Charles R. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 475-84(Dec 1971).

Clinical and statistical studies of the acute effects of the atomic bombs on the human populations of Hiroshima and Nagasaki are presented. The following data are included in the report: estimated exposed population, survivors and deaths by city and distance from hypocenter; percent mortality in Hiroshima as a function of distance from hypocenter; percent survival for both cities as a function of distance from hypocenter; average daily mortality rate in Hiroshima as a function of time post explosion and distance from hypocenter; types and magnitude of injuries among survivors; mortality among shielded and unshielded students in Hiroshima in relation to distance from hypocenter; severity of radiation injury syndrome in relation to distance from hypocenter; incidence of severe burns and clinical data on autopsy specimens as function of post explosion time and distance from hypocenter; histologic changes in cases of acute radiation injury; and factors attendant to atomic explosions, Hiroshima vs. Nagasaki. (E,R.B.)

12525 GROWTH AND DEVELOPMENT. Troup, Gary M. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 493-9(Dec 1971).

Microcephaly and mental retardation were noted in persons exposed in utero within 2000 meters of the hypocenter. Mental retardation correlated strongly with exposure as less than 15 weeks' gestation. The development of microcephaly appears to be independent of gestational age. The central nervous system malformations noted in the single autopsy of an in utero exposed survivor are similar to those found experimentally. The retardation of height and weight in individuals exposed prenatally, in infancy, or in early childhood is less well documented and is influenced by environmental factors other than radiation. (auth)

12526 LEUKEMIA AND RELATED DISORDERS. Anderson, Robert E. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 505-14(Dec 1971).

One of the delayed consequences of exposure to significant amounts of ionizing radiation is the development of leukemia. All forms of this disease are increased in prevalence in the proximally located survivors of the atomic bombs with the exception of the chronic lymphocytic variety, which is vanishingly rare among the general population in Japan. Both sexes and all age groups appear to be susceptible, but the most marked increment is among males who were less than 30 years of age at the time of the explosions.

Myelofibrosis with myeloid metaplasia is also apparently more prevalent in the surviving population. The remainder of the myeloproliferative disorders are rare in Japan and have not been documented with significant frequency among the survivors of the explosions. Despite extensive investigation the following issues cannot be addressed with certainty at this time: the basis of the discrepancies in the curves for incidence vs. dose between Hiroshima and Nagasaki, the presence or absence of a threshold effect, and the degree of identity between radiation-related leukemia and the spontaneous variety. (auth)

12527 MALIGNANT LYMPHOMA. Anderson, Robert E. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 515-19(Dec 1971).

On the basis of presently available information, there appears to be an increased prevalence of Hodgkin's disease, lymphosarcoma, reticulum cell sarcoma, and multiple myeloma in highly exposed Hiroshima survivors (≥100 rads). Proximally located males who were less than 25 years of age at the time of the explosions are most highly at risk and the attendant disease is characterized by a constricted appearance time. However, there are no other clinical or morphologic parameters that allow designation of an individual case or group of cases as being radiation related. Similar relationships between exposure and the subsequent development of lymphoma are not evident in the population of Nagasaki. Possible explanations for this discrepancy include defined physical differences in the radiation spectra emitted by the two bombs and genetic differences between the two populations at risk. (auth)

12528 CARCINOMA OF THE THYROID. Key, Charles R. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 521-3(Dec 1971).

The carcinogenic effect of ionizing radiation on the human thyroid gland seems to be well established by studies involving a variety of exposed populations. The large ABCC series of occult thyroid carcinomas has indicated some interesting features of those lesions in addition to the radiation relationships. (auth)

12529 RADIATION AND LUNG CANCER. Cihak, Robert W. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 525-8(Dec 1971).

Inhalation of radioactive particulate material is associated with an increased incidence of pulmonary neoplasia. Similar evaluation of populations exposed to external radiation is less conclusive. Preliminary information suggests a possible increased prevalence of carcinoma of the lung in highly exposed survivors of the atomic bombs. Synergistic factors, which may be of critical importance, are also under current evaluation. (auth)

12530 CARCINOMA OF THE SKIN. Key, Charles R. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 529-30(Dec 1971).

Based upon 25 years of accumulated experience, there is no evidence from ABCC Pathology Department material to suggest that skin cancers attributable to radiation have occurred in atomic bomb survivors. However, there have been at least three cases of skin cancer arising in scars of bomb related injuries. (auth)

12531 BONE TUMORS. Yamamoto, Tsutomu (Atomic Bomb Casuality Commission, Hirsohima). Hum. Pathol.; 2: No. 4, 531-2(Dec 1971).

An evaluation of 163 benign and malignant primary bone tumors documented at autopsy and in the surgical series revealed 25 tumors among members of the Life Span Study Sample; 12 malignant tumors, six of which were multiple myeloma; and an insufficient number of tumors among members of the population under evaluation to determine a putative relationship between exposure and the subsequent development of bone tumors. (auth)

12532 CARCINOMA OF THE LIVER. Jordan, Scott W. (Atomic Bomb Casuality Commission, Hirsohima). Hum. Pathol.; 2: No. 4, 533-4(Dec 1971).

A study delineating epidemiologic factors in primary carcinoma of the liver was done utilizing the Atomic Bomb Casualty Commission autopsy series in Hiroshima and Nagasaki. The autopsy population includes persons exposed under various known conditions to the 1945 atomic bombs as well as unexposed individuals. No association between hepatoma and atomic bomb exposure was found, but interesting differences were delineated between the Nagasaki and Hiroshima populations. The prevalence rate of hepatic carcinoma was three times greater in Nagasaki than in Hiroshima, whereas the prevalence rate of cirrhosis of the liver was the same in both cities. The greater prevalence of primary carcinoma of the liver in Nagasaki was explained in part by the greater tendency of cirrhosis to be associated with hepatoma in that city. (auth)

12533 CARCINOMA OF THE STOMACH. Yamamoto, Tsutomu (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 535-7(Dec 1971).

Despite several major efforts, a definitive and consistent relationship between ionizing radiation and carcinoma of the stomach has not been documented among the atomic bomb survivors. However, several bits of information suggest that such a relationship may be shown in the future as more case material becomes available. (auth)

12534 CARCINOMA OF THE PROSTATE. Jordan, Scott W. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 539(Dec 1971).

Carcinoma of the prostate with metastases has shown no differential prevalence rate among the various exposure categories of atomic bomb survivors and nonirradiated age matched patients. A detailed search for occult prostatic carcinoma was initiated several years ago, with examination of multiple sections of the prostate from the Hiroshima and Nagasaki autopsy series. Statistical analysis is not yet complete, but preliminary results indicate no differences in prevalence rates among atomic bomb exposed subjects at varying distances from hypocenter and age-matched nonexposed subjects in the Hiroshima or Nagasaki study populations. A high prevalence rate of occult prostatic carcinoma in men 80 years and older was found in this study, comparable perhaps to the occurrence rate of this neoplasm in the United States male population. (auth)

12535 OTHER TUMORS. Steer, Arthur (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 541-6(Dec 1971).

Tumor incidence among human survivors of the atomic bombings of Hiroshima and Nagasaki was studied. The types of tumors studied include: carcinomas of the breast; cancer of the ovary, uterus, and cervix; carcinomas of the gall bladder and extrahepatic bile ducts; and salivary gland tumors. Tumor incidence among children exposed pre- or postnatally to the atomic bombings was also studied. The statistical significance of tumor incidence was determined in all cases. (E.R.B.)

12536 CARDIOVASCULAR DISEASE. Gould, Sylvester E.; Anderson, Robert E. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 547-9(Dec 1971).

No relation between previous exposure and atherosclerotic vascular disease was documented among the surviving populations of Hiroshima and Nagasaki. In comparison with Western experience, several interesting discrepancies were noted with respect to the character, distribution, and magnitude of cerebral and cardiovascular disease. These differences are tentatively ascribed to environmental factors. (auth)

12537 LATE GONADAL RADIATION EFFECTS. Jordan, Scott W. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 551-8(Dec 1971).

Acute radiation changes in the ovary and testis are reviewed and the one testicular study of late effects done at ABCC is reported in detail. Testicular tissue of atomic bomb survivors who came to autopsy was examined for evidence of radiation and aging changes. Survivors within 1400 m. from the hypocenter were compared with distally and nonexposed subjects, using several histologic parameters. Statistical tests showed significant differences in the prevalence at death of tubular sclerosis and vascular hyalinization between Hiroshima survivors within 1400 m. from the hypocenter and control groups. Very significant ($0.01 < p < 0.001$) differences in seminiferous tubular sclerosis were found between survivors within 1400 m. who received an estimated whole-body radiation dose of 300 rads or more, the remainder of the group within 1400 m., and the other comparison groups. Also, significant age dependent testicular changes were found. Finally, a smaller population of Hiroshima survivors within 1400 m., age 60 years or more at the time of the bomb, had recorded signs or symptoms of radiation sickness than did their younger counterparts, which is consistent with a higher radiation mortality rate in men over 60 years of age. (auth)

12538 APLASTIC ANEMIA. Kirshbaum, Jack D.; Anderson, Robert E. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 559-60(Dec 1971).

The status of aplastic anemia as a delayed consequence of exposure to the atomic explosion remains unclear. The single published pathologic study in this regard includes an insufficient

number of Life Span Study Sample persons with the disease to allow meaningful comparisons. The infrequent occurrence of this entity at autopsy in recent years suggests that future experience will be limited. (auth)

12539 CENTRAL NERVOUS SYSTEM. Jordan, Scott W. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 561(Dec 1971).

The incidence of cerebral senile histologic changes, including Alzheimer neurofibrillary change and senile plaques, among the Japanese was studied using material from routine autopsies performed in Tokyo, Hiroshima, and Nagasaki. The ABCC autopsy population was used as the source of most of the material from the latter two cities. Some subjects in the study were bomb survivors, but numbers of subjects were too small for statistical contrast between exposed and nonexposed individuals. The age-specific occurrence rates of Alzheimer neurofibrillary change and of senile plaque are given in tabular form. (E.R.B.)

12540 AGING. Anderson, Robert E. (Atomic Bomb Casuality Commission, Hiroshima). Hum. Pathol.; 2: No. 4, 567-71(Dec 1971).

A number of biochemical and morphologic parameters were applied to the populations under study at the ABCC. Thus far only one such study has shown a significant discrepancy between the various segments that would suggest the possibility of acceleration among this group of persons. Alternative explanations for this finding are discussed, and it is concluded that the parameters employed may not be sensitive enough to detect changes of the magnitude expected. (auth)

12541 EFFECT OF MEDICINAL RADIATION EXPOSURE ON THE MEMBRANE PERMEABILITY OF THE RED CELLS IN THE CIRCULATION. Geszti, O.; Eloes, I.; Bojtor, I.; Predmerszky, T.; Lovanyi, I. (Frederic-Joliot-Curie Forschungsinstitut fuer Strahlenbiologie und Strahlenhygiene, Budapest). Strahlentherapie; 142: No. 2, 213-18(Aug 1971). (In German).

Following a single radiography of the stomach, the hemoglobin content in the blood of patients rose, at the same time the resistance of the red blood cells against ultrasound was diminished. By reduction of the tube current, the observed effects decrease, by prolonged examination they increase. The authors explain this observation by the radiation effect acting on the red cell membranes. The method described, by its sensitivity, is able to detect the biological effects of small doses of ionizing rays, and to derive pecularities of the medicinal radiation stress from the different action of doses given under various technical conditions. (auth)

12542 ARTIFICIAL SALIVARY GLAND REPLACEMENT FOR RADIATION-INDUCED XEROSTOMIA. Rubin, Philip; Bales, Harold; Keys, Henry (Univ. of Rochester, N. Y.). Radiology; 101: No. 3, 695-6(Dec 1971).

Irradiation of salivary gland tissue during radiotherapy of head and neck cancer can cause severe xerostomia. A system to provide artificial salivary flow is described that uses a continuous infusion pump and a subcutaneous tube. (auth)

12543 CASE REPORT DEALING WITH NEOFORMATION OF MALIGNANT TUMORS DURING CYTOSTATIC THERAPY. Renner, Kh. (Burgess Hospital, Basel). Strahlentherapie; 142: No. 3, 308-11(Sep 1971). (In German).

Three own cases are added to the few published observations of secondary tumors developing despite previous cytostatic therapy. (auth)

12544 CLINICAL AND BIOLOGICAL CONSEQUENCES OF NUCLEAR EXPLOSIONS. Andrews, Gould A. (Oak Ridge Associated Universities, Tenn.); Haywood, Fred F. Practitioner; 207: No. 1239, 331-42(Sep 1971). Radiat. Biol.; 20: No. 1,

The effects of nuclear explosions and excursions (an accidental or unintentional assembly of a critical mass of fissionable material) are tabulated. Taking an overpressure of 15 psi as the threshold for lung damage and a thermal radiation intensity of 5 cal/cm^2 as that required to produce second-degree burns, the distance for these figures to be attained, together with those for 100 rads and for 10 rads initial total radiation dose, are given for various explosive yields both at ground level and in the air. The probable neutron and γ ray doses 3 m from various nuclear excursions are compared. The effects of blast, flash, and total-body irradiation are discussed, and the cerebrovascular, gastrointestinal, and hemopoietic syndrome considered. The radiation effects in embryos are especially noted. The treatment of patients is considered and the biological effects of γ radiation neutrons, total-body irradiation, β irradiation, irradiation by ingested radionuclides, and delayed radiation effects, both somatic and genetic, are discussed. (UK)

12545 RUKOVODSTVO PO ORGANIZATSII MEDITSINSKOGO OBESPRECHNIYA PRI MASSOVYKH PORAZHENIYAKH NASELENIYA. TOM 2. (Manual for the Organization of the Medical Services During a Massive Attack on the Population. Volume 2). Burnazyan, A. I. (ed.). Moscow; Izdatel'stvo Meditsina (1971). 432p.

The organization of the public health and medical services during a wide-spread nuclear attack on the population is detailed. Surgical assistance during the stages of an evacuation, treatment of radiation injury as opposed to traumatic injuries, and the diagnosis and treatment of acute and chronic radiation sickness are discussed. Illness caused by toxic materials and biological (bacterial) warfare agents is considered. One chapter is devoted to various aspects of blood transfusion, and the effectiveness of whole blood, gamma-globulin, and blood substitutes for the treatment of radiation sickness. (K.S.W.)

12546 RADIATION-INDUCED SARCOMA OF BONE. Arlen, Myron; Higinbotham, Norman L.; Huvos, Andrew G.; (and others) (Sloan-Kettering Inst. for Cancer Research, New York). Cancer; 28: No. 5, 1087-99(Nov 1971). (CONF-710529-1).

From twenty-fourth annual scientific session of the James Ewing Society; Portland, Oreg. (6 May 1971).

During the period 1931 to 1970, 50 cases of radiation-induced osteogenic sarcoma were seen at two hospitals. Twenty-two of these cases have previously been described. An additional 28 cases are reviewed for factors related to the development of neoplastic changes. In 35 patients, there was evidence of pre-existing bone pathology in the form of benign osseous growths. Fifteen patients had soft-part and visceral neoplasms, such as retinoblastoma, seminoma, and breast carcinoma, the involved bone lying in the pathway of the radiation beam. Symptoms ranged from a palpable tender mass in the involved bone to intestinal obstruction secondary to metastatic radiation-induced osteogenic sarcoma. Essentially all bones in the skeletal system appear to have been vulnerable. The radiation doses ranged from 1,200 rads given in a few weeks to 24,000 rads given over two years. Induction time covered a period of four through 30 years with a mean of nine years. Thirty-two of the patients developing this neoplasm have since died of their disease. (auth)

Radiation Effects on Plants

Refer also to abstracts 12258–12260, 12263–12266, 12311, and 12412.

12547 (COO-2085-2) EFFECTS OF IRRADIATION ON LICHENS AND LICHEN-FORMING FUNGI AND ALGAE. Technical Progress Report. (Michigan Technological Univ., Houghton. Dept. of Biological Sciences). Nov 1971. Contract AT(11-1)-2085. 17p. Dep. NTIS.

Effects of acute exposure to 1,000 kR of gamma radiation on patterns of uptake of ^{32}P by thalli of the lichen, Cladonia sylvatica, were determined under light and dark conditions. It was found that uptake was considerably reduced by irradiation and this was correlated with altered metabolism. Studies were conducted on chromosomes of Trebouxia and effects of radiation on content of acids in Cladonia. Chronic irradiation studies were conducted on lichens that were transplanted into irradiation fields during the spring and fall. Lichens transplanted in the spring and exposed to radiation for 150 days showed evidence of damage when they were within 18 ft of the radiation source. Irradiation forest studies were conducted on the lichens, Parmelia and Physcia, which were transplanted from shaded areas to sunny areas and vice versa. Records of ambient and bark temperature were made; tracings of thalli were made to determine growth; and nuclear volume of lichens was measured to evaluate radiation damage. Studies on the effects of gamma radiation on thalli of Peltigera polydactyla showed that the algal component was the first to be affected by irradiation. (H.L.W.)

12548 BODY RESISTANCE OF A FUNGUS PULLULARIA PULLULANS (DE BARY) BERKH TO THE LETHAL EFFECT OF DECAY OF RADIOPHOSPHORUS INCORPORATED INTO DNA. Korolev, V. G. (Physical-Technical Inst., Leningrad). Tsitologiya; 13: No. 10, 1311-13(Oct 1971). (In Russian).

The resistance of a yeast-like fungus, Pullularia pullulans, to the decay of incorporated radiophosphorus was investigated in comparison with that of a diploid strain of Saccharomyces cerevisiae. The results of this experiment show the total resistance of P. pullulans to this effect and suggest that cells of P. pullulans may have a strong system of DNA-reparation that differs qualitatively from the same system in yeast cells. (auth)

12549 STUDIES ON THE ACCELERATION OF GERMINATION IN CARROT SEED. II. EFFECTS OF X RAY AND ULTRA-

VIOLET LIGHT IN THE GERMINATION OF CARROT SEED. Kwon, Oh Yong. Korean J. Bot.; 13: No. 2, 15-20(1970).

The germination of each group irradiated with x rays for 4, 6, and 7 sec was more delayed than those of the control group. However, the germination of each group irradiated with x rays for 2, 3, and 4 sec was accelerated over those of the control group. The irradiation by ultraviolet light was carried out at the distance of 20 centimeter by a Toshiba germicidal lamp that produced the wavelength of 2537 A. The germination of each group irradiated with ultraviolet light for 9, 15, 20, and 40 min was more delayed than those of the control group, but the germination of carrot seed was accelerated by adequate dosage of ultraviolet light. Consequently, it was suggested that the inhibited substance contained in carrot seed would be a fatty substance, because the germination of carrot seed was more accelerated by the treatment of acetone than by x ray and ultraviolet light. (Korean Sci. Abstr.)

12550 RESEARCH OF THE RADIATION BIOCHEMISTRY OF PLANTS. II. THE EFFECT OF CHRONICAL GAMMA-RAYS IRRADIATION ON THE METABOLISM OF AMINO ACIDS AND SUGARS IN PEA AND WHEAT PLANTS. Jiracek, V.; Kryzanek, R.; Kostir, J. (Charles Univ., Prague). Rostlinna Vyroba; 16: No. 6, 657-70(1970). (In Czech).

The chronic irradiation of pea and wheat plants by gamma rays under the field experiment affected the content of amino acids and saccharides in the aboveground portion and in the roots of the plants not only in the irradiated generations X_0 but also in the filial non-irradiated generations X_1 and X_2. The irradiation of wheat and pea plants has namely affected the content of the glutamic acid and the metabolically related amino acids (glutamine, γ-aminobutyric acid, proline) and serine, threonine as well as glycine, arginine and lysine. Usually the amino acids connected with metabolism of saccharides are involved. The decrease of the content of glutamic acid in the aboveground portions of the younger pea and wheat plants in the X_0 generation was accompanied by the increase of the content of the γ-amino butyric acid similarly as in the aboveground portions of the young wheat plants of the X_1 and X_2 generations. This was not so in the pea plants which indicated a higher activity of the glutamate—decarboxylase. In wheat, the decrease of the content of the glutamic acid is usually accompanied by the decrease of the proline content. The changes in the content of arginine and lysine affected pea plants significantly only in the X_0 generation while in wheat the effect was found also in X_1 and X_2 generations. The chronic irradiation inhibited the biosynthesis of saccharose in the pea plants of all the generations (X_0, X_1, X_2) while in wheat only the X_0 generation was influenced. The irradiation also retarded the formation of the glucoside of pisatoside in the aboveground parts of pea in all the three generations, though in young plants only. Also the transport of fructose from the aboveground parts to the roots of pea and wheat was influenced. (auth)

12551 RESEARCH OF THE RADIATION BIOCHEMISTRY OF PLANTS. I. CHRONICAL EFFECT OF GAMMA-RADIATION ON THE METABOLISM OF PHOSPHORUS IN PEA AND WHEAT. Jiracek, V.; Kryzanek, R.; Votruba, I.; Kostir, J. (Charles Univ., Prague). Rostlinna Vyroba; 16: No. 6, 645-56(1970). (In Czech).

The effect of the chronic irradiation with gamma rays on the dynamics of phosphoric substances was examined in pea and wheat plants under the field experiments. The content of various fractions of phorphorus both in the irradiated X_0 generation and the two non-irradiated F-generations (X_1 and X_2) was examined. The ionizing irradiation stimulated the intake of phosphorus by plants from soil affecting the increase of the total amount of phosphorus, especially in the aboveground parts of pea and wheat plants of the X_0 generation. The content of both phosphorus insoluble in ethanol and phosphorus soluble in acids increased. The content of these fractions of phosphorus in wheat roots increased while it tended to decrease in pea. The content of phosphorus soluble in ethanol (presented mainly by phospholipides) in wheat in the aboveground parts of X_0 generation decreased while it increased in pea, except for the roots of some older plants. The content of the nucleic acids increased in the aboveground parts of wheat of the X_0 generation markedly, whereas the increase in pea was less significant. The content of nucleic acids in the roots of pea and wheat decreased. The content of RNA increased significantly in the aboveground portions in both younger and older plants while in pea only in younger plants. The content of DNA in the aboveground portions of the younger peas and wheat plants usually decreased. The changes caused by the ionizing radiation had comparatively little effect even in the F generations X_1 and X_2 of pea and wheat, already affected by the reparation processes. (auth)

12552 RELATIVE BIOLOGICAL EFFECTIVENESS OF BETA PARTICLES FROM TRITIUM AND GAMMA RADIATION. Oliver, R.; Hall, E. J. (Churchill Hospital, Oxford). pp 343-5 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France: Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Various values for the RBE of tritium β particles and γ radiation measured in different experimental systems are reported that range from 1.0 to 1.7. Some of the experiments confirmed an increased value in the RBE at low dose rates. Further experiments were made using the reduction in growth of the primary root cells of Vicia faba seedlings as the measure of radiation damage. For a dose rate of 46.3 rads/hr, the lines corresponding to T_2O and ^{60}Co γ radiation were superimposed (RBE = 1). But at 1.5 rad/hr, the two lines were separated, corresponding to a RBE of 1.6. With an average dose of a few rads, the distribution of energy deposition in spheres is not uniform; for a relatively high average dose (200 rads), the energy deposition is uniform for both types of radiation. An increase in RBE at lower dose rates for low energy beta particles relative to γ radiation is expected from considerations of the various published values. (France)

12553 EFFECT OF ^{60}Co IRRADIATION AND ULTRA SOUND ON BARLEY SEEDS. Kiviniitty, K.; Sarvaranta, J.; Pitkaenen, U. (Univ. of Oulu, Finland). Strahlentherapie; 142: No. 2, 258-60(Aug 1971).

The effect of the water content of barley seeds was studied after irradiation with ^{60}Co and ultra sound. Radiosensitivity increased with the rise in the water content. The LD_{50} decreased considerably when the water content rose. An ultra sound field counter to the ^{60}Co radiation increased radioresistance in growing barley seeds. (auth)

12554 DIFFERENCE IN THE EFFECTS OF 14 MeV NEUTRONS AND LOW LET RADIATION ON CELL ELONGATION GROWTH IN BARLEY. Cercek, L.; Ebert, M.; Greene, D. (Christie Hospital, Manchester, Eng.). Int. J. Radiat. Biol.; 20: No. 5, 485-91(1971).

Experiments were made to compare the effect of 14 MeV neutrons, ^{60}Co γ radiation, and 300 kVp x rays on the growth of the first leaves and coleoptiles of Proctor's Barley (Hordeum vulgare [var. Proctor]). Dry seeds or seeds 48 hrs after germination were irradiated in the dose range 0 to 60 K rads. Dose effect curves obtained after irradiation of dry seeds showed that low LET radiations reduced growth of the first leaf to 20% and that of the coleoptile to 60% of the controls. It was suggested that these results, and the higher plateau in the coleoptile curves were due to the leaf growing mainly by cell division and the coleoptile mainly by cell elongation. The results obtained from irradiation of dry seeds showed a different effect of 14 MeV neutrons on cell elongation compared with the other radiations, but the difference was not observed with seedlings. It was suggested that the effect of the neutrons was on a precursor system in the dry seed, and might be due to differences in neutron-energy deposition. The response to low LET radiations was similar in both dry and wet systems. (UK)

12555 UNEXPECTED ADDITIONAL RECOVERY FOLLOWING A FIRST X-RAY DOSE TO A SYNCHRONOUS CELL CULTURE. Horsley, R. J.; Laszlo, A. (Ontario Cancer Treatment and Research Foundation, Hamilton, Can.). Int. J. Radiat. Biol.; 20: No. 6, 593-6(1971).

Survival curves are presented for Oedogonium cardiacum, following single doses and two dose fractions of x radiation, given in the G phase of the cell cycle. Additional survival beyond that expected from complete recovery from sublethal damage was observed, e.g. the results showed a survival three times higher than that expected following a dose of 1400 rads + 4200 rads. Additional survival was also seen in cells irradiated in the DNA synthetic state S_4 for G_1 and S cells irradiated under hypoxic conditions, the same phenomenon was observed, but to a lesser extent. (UK)

12556 RADIOSENSITIVITY OF WHEAT SEEDLINGS AND SULFHYDRYL CONTENT. Semerdzhyan, S. P.; Nor-Arevyan, N. G.; Saakyan, A. G.; Grigoryan, Z. D. Biol. Zh. Arm.; 24: No. 3, 106-7(Mar 1971). (In Russian).

Two-day old wheat seedlings were subjected to 300 R of gamma radiation and subsequently examined for signs of growth suppression, chromosomal aberrations, and total SH-group content. Rate of growth of the stalks was the criterion for dividing the population into two groups: fast and slow. The fast growth seedlings had a lower sulfhydryl content and a higher percentage of chromosomal aberrations. (K.S.W.)

12557 GROWTH AND METABOLISM OF YEAST CELLS AFTER LETHAL X-IRRADIATION. Svihla, G.; Schlenk, F.;

Dainko, J. L. (Argonne National Lab., Ill.). Int. J. Radiat. Biol.: 20: No. 5, 461-74(1971).

The yeasts Candida utilis and Saccharomyces cerevisiae were x-irradiated (2×10^5 R, 0.1% and 1.0% survivors) and incubated for 24 to 48 hr in culture medium. A three- to five-fold increase in cell weight occurred, but the process of budding was abnormal. In S. cerevisiae, multiple and lateral budding was observed while C. utilis produced one greatly elongated, sometimes bifurcated, bud which was much larger than the parent cell. In C. utilis, irregular structure of the bud wall was indicated by fluorescence staining with Primulin. The buds were deficient in respiration and DNA synthesis, but nitrogen assimilation, RNA, and ATP synthesis were found to resemble that of the parent cell. Ultra-violet micrography revealed that the junction between parent cell and bud was not closed. The buds contained vacuoles which were capable of storing newly synthesized material. (UK)

Radiation Effects on Microorganisms

Refer also to abstracts 12240, 12257, 12313, 12352, and 12412.

12558 EFFECT OF THE MUTATIONS REC B AND POL A ON γ-RAY INDUCED DNA SYNTHESIS IN A TEMPERATURE SENSITIVE DNA A MUTANT OF ESCHERICHIA COLI K12. Emmerson, P. T. (Univ. of Newcastle Upon Tyne, Eng.). Nature (London) New Biol.; 233: No. 41, 214-15(13 Oct 1971).

It was found that strains of E. coli carrying the mutation DNA A are unable to grow at elevated temperatures, apparently because they cannot initiate a new round of DNA synthesis, but that DNA synthesis can be induced in these strains at elevated temperature by exposure to γ radiation. It is thought possible that a radiolysis product, perhaps a single strand break in the DNA, may initiate a new cycle of DNA synthesis, and it is suggested that the rec B^+ gene product might modify the initial γ-ray product in the DNA. Data are given on the extent of total DNA synthesis after 90 min at 30° and 41°C as a function of γ-ray dose to the DNA A83 rec B21 and DNA A83 rec B^+ strains; the DNA synthesis increased only in the rec B^+ strain at 41°C. This implies either that the radiation product in the DNA must be exercised by the rec B^+ gene product or that the γ-ray induced break needs to be motified by the rec B^+ gene product before DNA replication can occur. Some γ-ray induced DNA synthesis was also found to occur in the pol A mutant. (UK)

12559 INVOLVEMENT OF THIOL GROUPS IN DETERMINING RADIATION RESPONSES OF LACTIC ACID BACTERIA. Pradhan, P. G.; Nadkarni, G. B. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Res.; 48: No. 2, 386-93(Nov 1971).

Differential sensitivities to gamma irradiation of Lactobacillus arabinosus grown on glucose and arabinose were correlated with the relative involvement of thiol groups in the inactivation in vivo of aldolase and phosphoketolase, the respective cleavage enzymes operative in homolactic and heterolactic fermentation. The survival of the cells in presence of cysteamine was of the same order irrespective of the physiological state determined by the growth conditions, thus indicating that the protection afforded to the more sensitive pentose-adapted cells was greater in magnitude than to those grown on glucose. Cysteamine also preserved phosphoketolase, which seemed to have reactive thiol groups for activity, to a larger extent than aldolase. Intracellular glutathione levels required for phosphoketolase activity and glutathione reductase did not contribute to differentiating the survival responses of the organism. (auth)

12560 RADIATION RESPONSES IN LACTIC ACID BACTERIA IN RELATION TO ADAPTIVE ALTERATIONS IN FERMENTATIVE PATHWAYS. Pradhan, P. G.; Nadkarni, G. B. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Res.; 48: No. 2, 377-85(Nov 1971).

Radiation survival of Lactobacillus casei and Lactobacillus arabinosus grown on glucose and pentoses, respectively, was assessed with reference to uptake and utilization of glucose. It was observed that pentose-adapted organisms were more susceptible to gamma irradiation (0 to 200 kR). This was correlated with relative inactivation of the cleavage enzymes aldolase and phosphoketolase. It was observed that the latter enzyme was inactivated at much lower exposures than aldolase. The doses for 50% inactivation of these enzymes were 20 kR and 10 kR, respectively. The uptake of glucose was not affected by gamma irradiation. The results are discussed to suggest that metabolic parameters determining radiation sensitivity could be assessed with the same cell species in which induced physiological alterations could be effected. (auth)

12561 ULTRAVIOLET RADIATION SENSITIVITY OF WHITE MUTANTS AND RED WILD-TYPE SERRATIA MARCESCENS. Hanks, A. R.; Mroz, E. (Texas A and M Univ., College Station). Radiat. Res.; 48: No. 2, 312-18(Nov 1971).

White mutants of Serratia marcescens, which do not produce the nonessential pigment prodigiosin, were found to be more resistant to killing by ultraviolet light (uv) than the red-wild type. Pigment induction in a white mutant, which sensitizes to gamma rays, does not change this mutant's uv resistance. Therefore, prodigiosin does not appear to sensitize to uv killing in these strains. Possible differences in uv sensitivity due to uv-induced lysis and filament formation were checked, but not observed. Post-uv plating of red and white Serratia on caffeine and acriflavin was found to decrease the survival for both strains, reflecting the probable existence of repair. (auth)

12562 RESISTANCE OF BACILLUS SUBTILIS SPORES TO INACTIVATION BY GAMMA IRRADIATION AND HEATING IN THE PRESENCE OF A BACTERICIDE. III. FACTORS AFFECTING RATES OF INACTIVATION BY PHENYLMERCURIC NITRATE. Deasy, P. B.; Kuester, E.; Timoney, R. F. (Coll. of Pharmacy, Dublin). Appl. Microbiol.; 22: No. 4, 567-70 (Oct 1971).

Aqueous suspensions of Bacillus subtilis NCTC 8236 spores, surviving gamma irradiation from a cesium-137 source, exhibited an enhanced rate of inactivation compared to nonirradiated spores when heated with 0.04% phenylmercuric nitrate. The enhanced rate of inactivation, observable from survival curves, was noted when spores were irradiated with 150,000 rad under air in either the presence or absence of the bactericide. The magnitude of the enhanced inactivation rate increased as the irradiation dose under air increased from 150,000 to 300,000 rad. The inactivation rates of spores surviving irradiation with 150,000 rad under either oxic or anoxic conditions did not exhibit a simple quantitative relationship. The enhancement effect was observed when the severity of the heat treatment was increased by either reducing the pH from 8 to 6 or raising the temperature from 70 to 90°C. (auth)

12563 GIANT CELLS OF ESCHERICHIA COLI: A MORPHOLOGICAL STUDY. Allison, David P. (Oak Ridge National Lab., Tenn.). J. Bacteriol.; 108: No. 3, 1390-1401(Dec 1971).

Bacterial growth without division was observed in a giant cell-producing strain of Escherichia coli K-12. Giant cell production is controlled by the lon^- (failure of cell division after irradiation) and mon^- (formation of irregularly shaped cells) genes. Irradiation of a lon^- mon^- strain ($P678\text{-}A_4$) with low doses of ultraviolet or ionizing radiation results in the production of large, amorphous giant cells with 500 to 1,000 times the volume of the nonirradiated parents. The concentration of NaCl in the growth medium was found to influence irradiated-cell morphology. Low concentrations (0.2% NaCl) resulted in elongated cells, whereas spherical giant cells were produced in the presence of high salt (1% NaCl) concentrations. Thin-section electron microscopy revealed an extensive network of intracellular membranes forming vacuoles, vesicles, and cisternae. These structures bear a striking resemblance to the rough and smooth membranes (endoplasmic reticulum, Golgi complex, vacuoles, etc.) found in eucaryotic cells. (auth)

12564 EFFECTS OF THE RECIPIENT STRAIN AND ULTRAVIOLET IRRADIATION ON TRANSDUCTION KINETICS OF THE PENICILLINASE PLASMID OF STAPHYLOCOCCUS AUREUS. Rubin, Sally J.; Rosenblum, E. D. (Univ. of Texas, Dallas). J. Bacteriol.; 108: No. 3, 1192-9(Dec 1971).

When the penicillinase plasmid of Staphylococcus aureus PS 81 $(P_{81})(T_{81})$ was transferred to its cured derivative of PS 81 $(N_P)(T_{81})$, there was a fivefold increase in the transduction frequency of penicillinase plasmid markers after ultraviolet (uv) irradiation of the phage instead of the expected decrease typical for plasmid-borne markers. These results were independent of the transducing phage, the donor, and the method of curing the recipient and were also obtained with a cured derivative of PS 80(PI_{80}). With PS 52, a naturally occurring penicillin-sensitive strain, and a cured transductant of PS 52 as the recipients, typical plasmid kinetics were observed. The plasmid location of penicillinase plasmid markers in transductants was confirmed by their instability in ethidium bromide (EB). In a cross between isogenic plasmids (PI_{258}penZ cad × PI_{258}penI asa ero), transductants were doubly selected for cadmium and erythromycin resistances. There was a twofold increase in transduction frequency after UV irradiation of the transducing phage and an increase in the proportion of recombinant type transductants. CsCl–EB density centrifugation revealed that plasmid deoxyribonucleic acid (DNA) was present in PS 81$(P_{81})(N_T)$ and its cured derivative [PS 81$(N_P)(N_T)$], but not in PS 52. Sucrose gradient analysis of

plasmid DNA showed that the penicillinase plasmid of PS 81(P_{81}) (N_T) was larger than the plasmid in its cured derivative. Thus, the cured derivative contains plasmid DNA which appears to recombine with the incoming plasmid, causing the rise in transduction frequency noted after uv irradiation of transducing phage. (auth)

12565 DEPENDENCE OF THE OXYGEN ENHANCEMENT RATIO (OER) ON THE TEST OF DAMAGE IN IRRADIATED BACTERIA. Forage, A. J. (Hammersmith Hospital, London). Int. J. Radiat. Biol.: 20: No. 5, 427-36(1971).

The OER for induction of bacteriophage from lysogenic bacteria (Salmonella typhimurium and Escherichia coli) was lower, and that for inhibition of β-galactosidase synthesis was higher, than the OER for cell killing. The relatively low OER for the release of prophage indicated that the radiation sensitive target for induction is probably DNA. The high OER for inhibition of induced enzyme synthesis, on the other hand, might be indicative of damage to the bacterial membrane such that entry of inducer molecules into the cell is inhibited. The results supported the hypothesis of Alper (1968) that the damage enhanced by the presence of oxygen during irradiation might be associated with the cell membrane. Beams of 250 kVp x rays and 7 MeV electrons were used in these experiments. (UK)

12566 GENETIC DETERMINANT IN ESCHERICHIA COLI AFFECTING THYMINELESS DEATH AND ULTRAVIOLET SENSITIVITY. Wilkins, A.; Gallant, J.; Harada, B. (Univ. of Washington, Seattle). J. Bacteriol.; 108: No. 3, 1424-6(Dec 1971).

We have infected Escherichia coli strain B3 with F′ factors carrying different lengths of the K-12 chromosome. When the F′ factor carries the tsx to purE segment, the resulting hybrid merodiploid shows increased sensitivity to thymineless death, although leaky deoxyribonucleic acid synthesis is unaffected, as well as increased sensitivity to ultraviolet irradiation. The dominant or partially dominant character of the effect indicates that it is not a product of allelic differences between E. coli K and B at either ras or lon. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 12431 and 12562.

12567 (NP-tr-1938) SOME BIOCHEMICAL CHANGES INDUCED IN FRESH FISH BY GAMMA IRRADIATION. Kardashev, A. V.; Bobrovskaya, N. D.; Klyashtorin, L. B.; Maslennikova, N. V. Translated from Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr.; 73: 53-68(1970). 26p. Dep. NTIS (U. S. Sales Only).

Biochemical changes induced in fresh fish during γ processing were investigated. Irradiation of fresh fish (sheatfish) muscle caused decreases in cathepsin activity with increasing irradiation dosage. At a dosage of 2 Mrad decrease in activity was 23%. With an increase in irradiation dosage from 0.3 to 2 Mrad the solubility of actomyosin fractions of sheatfish muscle decreased, apparently caused by an aggregation of contractile proteins of muscle upon irradiation. Changes in the content of free amino acids in the muscles of irradiated fish were found to be related to the specific action of radiation on the break-up speed of separate amino-acids and their splitting from a protein molecule. On the basis of electrophoretic investigations it was concluded that a small number of low-molecular products split from a protein upon irradiation. This was also confirmed by an increase in optical density of protein-free filtrates of sheatfish muscle in the ultra-violet part of the spectrum. (C.H.)

12568 (NP-tr-1939) APPLICATION OF GAMMA IRRADIATION IN COLD STERILIZATION OF SALT AND SPICE MIXTURES. Dutova, E. N.; Kardashev, A. V.; Goftarsh, M. M. Translated from Tr. Vses. Nauch.-Issled. Inst. Morsk. Ryb. Khoz. Okeanogr.; 73: 69-72(1970). 8p. Dep. NTIS (U. S. Sales Only).

From Processing of Fishery Products.

A number of condiments used in food processing (cooking salt, bay leaves, dry carrots, dry onions, granulated sugar, and ground black pepper) were examined for the presence of bacteria and fungi. From 200 to 83,200 spores/gram of condiment were found, with the largest number found in ground black pepper. The possibility of using γ radiation for the sterilization of microflora on condiments was investigated. A mixture of cooking salt and spices (cayenne pepper, black pepper, white pepper, pimento, cloves, nutmeg, cinnamon, ginger, and cardamon) was exposed to γ radiation from a ^{60}Co source at various doses and dose rates. Results showed that γ irradiation at a dose of 0.2 mrad greatly reduced the number of bacteria and fungi and had no effect on organoleptic properties of the condiments. (C.H.)

12569 (SGAE-BL-41/1971) WHOLESOMENESS TESTING OF GAMMA-IRRADIATED APPLE JUICE FED TO MINIATURE PIGS FOR ONE ENTIRE YEAR. Adamiker, D.; Levinsky, H.; Folse, D. S. (Oesterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf. Institut fuer Biologie). [nd]. 143p. Dep. NTIS (U. S. Sales Only).

The wholesomeness of γ processed apple juice was evaluated using four groups consisting of five male and five female miniature swine fed either a normal ration, a 60% (dry weight basis) protein-rich supplemental diet together with 40% unirradiated apple juice, or apple juice irradiated with 0.4 or 0.8 Mrad during one entire calendar year. Animals were weighed weekly and no differences in weight gains due to irradiation of the apple juice were observed. Individual feeding was maintained throughout the experiment and feed left-overs estimated per meal. The swine seemed to be able to distinguish differences of palatability of the feed and tended to leave feed containing 0.8 Mrad irradiated apple juice 10 to 20% more often than the swine maintained on the other diets. (TSS) (auth)

12570 (UCD-34-P-80-9) RADIATION TECHNOLOGY IN CONJUNCTION WITH POSTHARVEST PROCEDURES AS A MEANS OF EXTENDING THE SHELF LIFE OF FRUITS AND VEGETABLES. Annual Report, April 15, 1970-January 1, 1971. Maxie, E. C. (California Univ., Davis. Dept. of Pomology). Jul 1971. Contract AT(11-1)-34. 234p. Dep. NTIS.

During the 1970 California harvest season, seven test shipments of irradiated strawberries were conducted using as near commercial conditions as possible, i.e., harvest, cooling, shipping and storage, and grading to determine the effectiveness of irradiation in controlling the incidence of decay after commercial handling. A ^{137}Cs portable γ source was used and irradiation levels were 150 and 235 Krads (maximum absorbed doses of a uniformity ratio of 1.35). Two of these shipments were marine surface shipments using commercial refrigerated containers. The remaining were all via refrigerated trucks. The results of these tests showed irradiation to be significantly effective in controlling decay during and after shipments of a long duration such as the marine shipment to Honolulu. The results from transcontinental shipments via refrigerated trucks showed less effect, although decay control was consistently better with the irradiated sample. Irradiation to a maximum dose of 150 Krads (111 Krads minimum) had a slight but consistent superiority for controlling decay than the maximum dose of 235 Krads (173 Krads, minimum). (auth)

12571 PROBLEMS AND COUNTERPLANS OF RADIATION STERILIZATION. Sunada, Takeshi (Radiation Center of Osaka Prefecture, Sakai). Genshiryoku Kogyo; 17: No. 7, 38-42; 81(Jul 1971). (In Japanese).

The sources of concern in the radiosterilization of medical sanitary supplies are the decreasing quality of supplies and the necessary dose (increased dose to elevate the sterilization effect). As the dose is increased, the number of surviving bacteria decreases. When the number of surviving bacteria is taken as the ordinate and the dose as the abscissa to draw a survival curve, at high doses, the curve turns a gradual line against the abcissa (dose). It shows that however large a dose is given, there is a limited probability that surviving bacteria exist in bacterial masses. The sterilizing dose depends on the initial pollution count of supplies, ranging in a wide area from 0.004 Mrad exceeding 0.4 Mrad in Pseudomonas suspended in water according to the extent of radioresistance of the bacteria. It fluctuates from 0.14 Mrad to 0.38 Mrad in a dry state for B. pumilus with great resistance. The above applies to homologous strains and identical environments. If, in reality, many types of bacteria are supposed to adhere to the environments that are not necessarily identical, irradiation of 2.5 Mrad is thought to be sufficient. The indicators for the level of symmetry of dose should be established immediately in consideration of the technical limit, economy of irradiation, and the decreasing quality of the supplies. A color indicator is being developed in order to monitor the sterilizing procedure, and being manufactured on trial as biological indicators are indicators in strip and pill forms that allow a homogeneous scattering of surviving bacteria after irradiation for quantitative analysis with the base dissolved in the sterile water. (Japan)

12572 EFFECT OF CONTINUOUS AND FRACTIONATED DOSES OF GAMMA RADIATION ON CALANDRA ORYZAE L. Zutshi, M. K. (Cyanamid Pvt. India Ltd., Bombay). Bull. Grain Technol.; 6: No. 3, 164-5(1968).

Adults of Calandra oryzae (1 to 2 days old) were irradiated with single and fractionated doses of gamma rays at a ^{60}Co source of 590 curie strength. The single dose comprised of 6000 rep at the rate of 53000 rep/hr and the fractionated doses were of 2000 rep at the rate of 17400 rep/hr, applied thrice at 24 hr interval. The

adults were found more susceptible to single dose than to fractions. Reproduction ceased with single as well as with fractionated doses. (BK) (Indian Sci. Abstr.)

12573 EFFECT OF GAMMA IRRADIATION OF AN ACID TEA SOIL FROM EAST PAKISTAN ON NITROGEN MINERALIZATION AND NITRIFICATION DURING SUBSEQUENT INCUBATION. Ishaque, M.; Cornfield, A. H.; Cawse, P. A. (Imperial Coll. of Science and Tech., London). Plant Soil; 35: No. 1, 201-4(Aug 1971).

Ammonium- and nitrate-N levels were determined after 13 weeks of incubation (30°C, 80% maximum water-holding capacity) of a tea soil (pH 4.2) that was subjected to varying doses of gamma irradiation (0.05 to 2.00 Mrad) just before incubation. The extent of accumulation of mineral-N ($NH_4 - N + NO_3 - N$) during incubation was little affected by any dose of gamma irradiation. Nitrate accumulation during incubation was not affected by 0.05 Mrad but decreased with increasing dose and was completely inhibited by doses of 0.5 Mrad or higher. The results are discussed in relation to the possible occurrence of heterotrophic nitrification in the acid tea soil. (auth)

12574 MICROBIOLOGICAL STUDY OF IRRADIATED SUGAR. Vajda, Oedoen; Gal, Ilona. Elelmiszervizsgalati Kozlemen.; 16: No. 3, 129-35(1970). (In Hungarian).

Practically germfree beet sugar could be obtained by a 2 Mrad irradiation in solid crystalline state, this dose having, however, no protecting effect against recontamination. A 4% concentration in a liquid culture medium of the sugar thus irradiated had no effect on the growth of B. cereus, L. mesentericus, L. plantarum, and two yeast test-strains. The same concentration of sugar irradiated by 100 Mrad inhibited the growth of the above bacterial strains more markedly, while a concentration of 2% showed a less marked effect. No antibiotic action on yeasts could be observed with either concentration. In a solid agar medium neither of these concentrations of sugar samples irradiated by 2 and 100 Mrad, resp., had any microbiological effect on bacterial (B. cereus, B. subtilis) or yeast strains. (auth)

12575 PRESENT SITUATION OF APPLICATION OF RADIATION ON FOODS. Matsuyama, Akira (Inst. of Physical and Chemical Research, Saitama, Japan). Aminosan Kyokai Gijutsu Bakai-ho; No. 116, 1-37(Apr 1970). (In Japanese).

Complete sterilization is required for medical supplies and medical appliances, while dose is varied according to purposes when radiopasteurization is applied for foods and feeds as their qualities change. The main purpose of the application of radiation on foods and feeds is to destroy microorganisms especially the Salmonellae. Though its application has not been sanctioned yet in Japan, 0.025 Mrad application is approved for killing insects of wheats, and 0.01 Mrad and 0.007 Mrad for preventing sprouting of potatoes and onions respectively in U.S.A. and U.S.S.R. Animal tests were continued in Japan considering such points as retention of radioactivity, degeneration of foods, and detrimental influences on man and domestic animals. The application is to be approved after the above problems are resolved. The application of radiation to potatoes and onions will be approved in the near future, but further study must be done for controlling ripening of apples and tomatoes. Less than 2.2 MeV γ rays, i.e., γ rays from ^{60}Co or ^{137}Cs, or less than 10 MeV electron beams seem to be applied safely. (Japan)

12576 EFFECT OF GAMMA RADIATION ON THE ASCORBIC ACID CONTENT IN STRAWBERRIES AND NATSUDAIDAI FRUITS. Kurosaki, Toshiharu (Hiroshima Agricultural Coll., Saijo, Japan). Hiroshima Nogyo Tanki Daigaku Kenkyu Hokoku; 4: No. 1, 50-4 (Dec 1970). (In Japanese).

Strawberries and Natsudaidai fruits were exposed to ^{60}Co gamma radiation at dose rates 2.5×10^5 R/hr and 3.4×10^5 R/hr. Both of them were divided into three dose groups, i.e. 100 Krad, 250 Krad, and 500 Krad. In each irradiation group of strawberries, immediately after irradiation, ascorbic acid of the reduced form decreased, while ascorbic acid of the oxidized form increased, and the total amount of ascorbic acid decreased. When stored at room temperature, the decrease of ascorbic acid of irradiated groups was little, while that of non-irradiated group was conspicuous. When stored for 30 to 60 days at 1°C after the irradiation, the 100 Krad group contained the highest percentage of the vitamin C. In case of Natsudaidai fruits, the vitamin C of the reduced form decreased, while that of oxidized form increased, and the total amount of the vitamin C decreased. The amount of the vitamin C transformed from the reduced form into the oxidised form was less than that of strawberries. After a long period of storage, the changes of the vitamin C content both in irradiated and non-irradiated groups were imperceptible. (Japan)

12577 GAMMA RADIATION FOR PRODUCT STERLIZATION. Ley, F. J. (Irradiated Products Ltd., Wantage, Eng.). J. Soc. Cosmet. Chem.; 22: No. 11, 711-23(14 Oct 1971).

The high penetrating power of γ radiation makes it particularly suitable for the sterilization of products in their final pack. The choice of radiation dose depends on the number and types of contaminants involved and on the influence of the environment on their radiation resistance. Radiation may have an adverse effect on some materials and products and these should be tested individually. The operation of radiation plants is briefly described with emphasis on the methods of process control. (UK)

12578 IRRADIATION OF FOOD PRODUCTS. Bull. Inform. Min. Agr.; No. 508, D1-4[nd]. (In French).

The preservation of foodstuffs by irradiation with ionizing radiations is an important aspect of the food industry. A general table of irradiated foodstuffs, authorized for human consumption in different countries, is presented. International legislation is currently being studied, but no decision has been taken by France on the subject. (France)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 14081.

12579 DIFFUSIONAL MOBILITIES OF PARTICLES, PORES, AND LOOPS. Nichols, F. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Contract AT(11-1)-Gen-14. Acta Met.; 20: No. 2, 207-14(Feb 1972).

The movement of macroscopic defects (usually pores or particles) through solids, has been analyzed. These analyses typically deal with only one specific combination of type of particle or pore, transport mechanism and driving force; furthermore they are usually restricted to spherical shapes, and involve the solution of sometimes complicated atomic diffusion fields. A unified treatment is developed for arbitrary shape, transport mechanism and driving force using the concept of a macroscopic defect mobility, which avoids the solution of the atomic diffusional field (which represents in some instances an intractable problem). Specific cases are treated for illustrative purposes including the movement of lenticular-shaped voids along thermal gradients in nuclear fuels, the thermal-gradient driven motion of dislocation loops by pipe-diffusion, and the rate of sliding of a grain boundary containing discrete particles. (auth)

12580 CONFERENCE ON ANELASTIC EFFECTS DUE TO DEFECTS AND PHASE TRANSFORMATIONS IN SOLIDS, LAUSANNE, SWITZERLAND, JUNE 24-26, 1970. J. Phys. (Paris), Colloq.; 71: No. 2, 1-280(1971). (In French and English). (CONF-700624).

Forty-seven papers were presented at the conference. The subjects treated were classified into four chapters: point defect interactions, lattices; phase transformations and interface phenomena; point defect interactions, dislocations; dislocation interactions, lattices. A separate abstract was prepared for each of twelve papers. Abstracts of three papers have appeared previously in NSA. For abstracts of these see 24: 51183, 25: 778 and 25: 27199. (France)

For abstracts of individual papers see: 12627–12631 and 12712–12718.

Corrosion and Erosion

Refer also to abstracts 13449 and 14484.

12581 (AERE-M-2461) REVIEW OF THE OXIDATION OF SOLID SODIUM BY GASES. Ainsley, R. (Atomic Energy Research Establishment, Harwell (England)). Oct 1971. 11p. Dep. NTIS (U. S. Sales Only). UK 13p.

By reviewing the published work on the oxidation of sodium by various gases it has been possible to estimate the corrosion rate of sodium surfaces by a variety of drybox atmospheres. Three typical cases of varying impurity level are considered and the oxidation controlling feature was found to be the access rate of the reacting gases to the sodium surface. In inert atmospheres containing not more than 1 ppM of oxygen the reaction rate is equivalent to 1.7×10^{-2} $\mu g\ s^{-1}$ of oxygen for a sodium surface of 10^{-3} m^2. Both of the other cases gave a higher oxidation rate. (auth)

12582 (SC-RR-710637) OXIDATION OF ERBIUM. Loescher, D. H.; Fuller, C. T. (Sandia Labs., Albuquerque, N. Mex.). Oct 1971. 50p. Dep. NTIS.

In order to obtain information on the oxidation of erbium metal, an ellipsometer was used to measure the thicknesses of oxide films which formed on the metal when it was exposed to air at pressures between 10^{-9} torr and 625 torr and at temperatures between 23 and 600°C. Measurements at low pressures showed that as much as 11 nm of oxide can form at pressures in the 10^{-6} torr range. Measurements at atmospheric pressure showed that an oxide film 6 to 12 nm thick forms very rapidly when erbium is exposed to air. It was determined that at ambient temperature and pressure and for time scales of days and months the growth of the oxide obeys logarithmic kinetics. However, at 625 torr and temperatures from 160 to 293°C the film thickness, d, is related to the time, t, by an equation of the form $d = At^{\alpha}$ in which A depends on the temperature and moisture content of the air and in which $\alpha \simeq 0.37$. Data taken after vacuum anneals for one hour at $\sim 10^{-7}$ torr and temperatures from 200 to 600°C showed that oxidation occurs during annealing. In all instances, the final oxide thickness was less than 40 nm. No evidence for cracking of the oxide was seen in scanning electron photomicrographs of the annealed samples. (auth)

12583 OBSERVATIONS ON SUSTAINED LOAD ENVIRONMENTAL CRACK GROWTH OF A TITANIUM 8Al–1Mo–1V ALLOY. Bucci, R. J. (Del Research Corp., Hellertown, Pa.); Paris, P. C. Corrosion; 27: No. 12, 525-30(Dec 1971).

Sustained load environmental cracking of a mill annealed titanium 8Al–1Mo–1V alloy was investigated by methods amenable to fracture mechanics. Two environments were considered: 3.5% NaCl solution and distilled water, both at room temperature. Varying amounts of crack propagation followed by subsequent crack arrest were detected at K levels considerably below an apparent K_{Iscc} (almost 2 to 1) that would be determined from a time to failure test technique. At crack arrest locations along the specimen surface, minute amounts of crack division were often observed under magnification. (auth)

12584 CORROSION BEHAVIOR OF ZIRCONIUM AND ZIRCONIUM–CHROMIUM ALLOYS IN STEAM AT TEMPERATURES BETWEEN 325 AND 700°C. Ullrich, Georg; Wiedemann, Karl-Heinz (Eidgenoessische Institutes fuer Reaktorforschung, Wuerenlingen, Switzerland). Z. Metallk.; 62: No. 12, 899-909 (Dec 1971). (In German).

It is well known, that the corrosion of zirconium alloys follows initially a parabolic rate law and after reaching a transition point changes to a linear rate law. The phenomena of this breakaway was investigated. The results in the system zirconium–chromium up to 2.5 wt % Cr in steam of 1 atm at temperatures between 325 and 700°C are discussed on the basis of a model, which was proposed earlier. The model proved to be useful in understanding the "breakaway"-phenomena. (auth)

12585 IMPROVEMENT OF THE CORROSION RESISTANCE OF La BY THE ADDITION OF Sc. Naumkin, O. P.; Terekhova, V. F.; Savitskii, E. M. (to Inst. of Metallurgy). Russian Patent 240,257. 21 Mar 1969. Filed 10 Jan 1968. (In Russian).

Lanthanum is used as an alloying additive for improving the properties of steel, cast iron, and other metals. The use of pure La independently is hindered by its low resistance to corrosion in air, even at room temperature. A process for improving the corrosion resistance of La is based on the addition of 0.01 to 30% scandium. (K.S.W.)

12586 OXIDATION OF Zr–Cu–Mo ALLOY IN CARBON DIOXIDE GAS AT ELEVATED TEMPERATURES AND PRESSURES. II. ESTIMATION OF THE OXIDE AND DIFFUSION LAYERS. Mrkous, Pavel; Staif, Milan; Benda, Karel (Factory for Construction of Nuclear Electric Power Plants, Plzen, Czech.). Jad. Energ.; 18: No. 1, 9-17(Jan 1972). (In Czech).

The diffused oxide layer on the surface of the alloy Zr–0.8 Cu–0.8 Mo following corrosion in CO_2 (1 to 50 atmospheres pressure) in the temperature range 400 to 700°C was analyzed. The content and distribution of alloying components and carbon in the oxide was determined by chemical analysis, x ray spectral analysis, and by a radiographic method. The distribution of oxygen and alloying components in the diffused layer was ascertained by x-ray spectral analysis and metallography. (tr-auth)

12587 OXIDATION OF Zr–Cu–Mo ALLOY IN CARBON DIOXIDE GAS AT ELEVATED TEMPERATURES AND PRESSURES. I. OXIDATION KINETICS. Mrkous, Pavel; Staif, Milan; Benda, Karel (Factory for Construction of Nuclear Electric Power Plant, Plzen, Czech.). Jad. Energ.; 17: No. 12, 401-7(Dec 1971). (In Czech).

The corrosion kinetics in CO_2 gas at 400 to 750°C are discussed for the alloy Zr–0.5 Cu–0.8 Mo. The corrosion rate for the latter alloy was compared with that for Zr–0.5 Cu–0.5 Mo and for Zr–2.5 Nb. Deviations from the parabolic law were examined, and the influence of such factors as temperature, pressure, presence of moisture in the gas was analyzed. The relationship between weight increase and oxide thickness is presented along with data on the distribution of oxygen between oxide and metal. (tr-auth)

12588 CORROSION OF NICKEL IN LIQUID SODIUM. Cheng, C. F.; Ruther, W. E. (Argonne National Lab., Ill.). Corrosion; 28: No. 1, 20-2(Jan 1972).

The corrosion of nickel in liquid sodium was investigated as a function of temperature and sodium velocity in a series of loop experiments. Additional data were obtained from the exposure of nickel specimens to the primary sodium in the core of the EBR-II reactor. The weight loss was found to be linear with time under the conditions investigated. The 0.76 power velocity dependence of the corrosion rate was characteristic of a liquid diffusion controlled dissolution process; however, the activation energy of 28.9 kcal/mole was somewhat greater than that associated with

this type of corrosion mechanism. The effects of oxygen concentration in sodium on the corrosion rate were small, as was the downstream effect. (auth)

12589 PASSIVATION OF CHROMIUM-CONTAINING IRON AND NICKEL-BASE ALLOYS IN AQUEOUS SOLUTIONS AT 289°C. Vermilyea, David A.; Indig, Maurice E. (General Electric Co., Schenectady, N. Y.). J. Electrochem. Soc.; 119: No. 1, 39-43 (Jan 1972).

A system which allows electrochemical studies to be conducted in relatively uncontaminated aqueous solutions at 289°C, using a reference electrode which permits potentials to be referred to the standard hydrogen electrode scale, is described. Current–potential curves for Type 304 stainless steel, Inconel 600, and other iron and nickel-base alloys containing less than 14% Cr are presented. It is found that passivation in dilute H_2SO_4 is more difficult at 289°C than at 25°C because of the faster attack by the acid at the high temperature. (auth)

12590 DISLOCATION PITS AND LIGHT FIGURES OF PURE TUNGSTEN BY ELECTROLYTIC AND CHEMICAL ETCHING. Tamura, Yoshio; Fujii, Tadayuki; Ohba, Yukio (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 35: No. 11, 1027-31(Nov 1971). (In Japanese).

Electrolytic and chemical etching conditions for revealing dislocation pits and light figures on the principal planes of zone-refined tungsten single crystals were studied. The results showed that clear dislocation pits on the (001) plane were easily produced by either electrolytic etching or chemical etching as previously reported and dislocation pits on the (111) plane were obtained by electrolytic etching in (16% NaOH + picric acid 4g) electrolyte. Dislocation pits on the (110) plane were not revealed even in the various etching conditions. Etching figures from which clear light figures on the (001), (111), and (110) planes could be obtained were revealed by either chemical etching in 30% $K_3Fe(CN)_6$ [1 part] + 3% NaOH [1 part] solution or electrolytic etching in sodium hydroxide solution containing picric acid. (auth)

12591 EFFECT OF OXYGEN ON THE CORROSION AND ELECTROCHEMICAL BEHAVIOR OF THE ALLOY SYSTEMS TITANIUM–VANADIUM AND TITANIUM–VANADIUM–ALUMINUM IN SULFURIC ACID. Brynza, A. P.; Kornilov, I. I.; Vavilova, V. V.; Mnuskin, I. P.; Maksimov, Yu. A. (Dnepropetrovsk State Univ., USSR). Prot. Metals (USSR) (Engl. Transl.); 7: No. 3, 248-50(May-Jun 1971).

Translated from Zashch. Metal.; 7: No. 3, 293-6(May-Jun 1971).

The corrosion resistance of these alloys, containing 0.1 to 0.5 wt % O, 2.5 wt % V, and 3 wt % Al, was studied at 20°C in 40 and 70% H_2SO_4. Corrosion rates were determined by the quantities of Ti passing into solution measured photocolorimetrically. (J.R.D.)

12592 MODERN CORROSION-RESISTANT STEELS AND ALLOYS. Babakov, A. A. Prot. Metals (USSR) (Engl. Transl.); 7: No. 3, 201-9(May-Jun 1971).

Translated from Zashch. Metal.; 7: No. 3, 237-48(May-Jun 1971).

The metallurgical industry is producing a great number of corrosion-resistant steels and alloys with different designations and having a high resistance to intercrystalline and shearing corrosion. Steels with a very low carbon content include brands 000Kh18N11, 000Kh17N13M2, and 000Kh17N15M3. Steels alloyed with nickel of the two-phase ferritic–austenitic class having a high resistance to intercrystalline corrosion and to corrosion under stress include brands 0Kh21N6B, 000Kh22N6, 0Kh21N6M2T, 000Kh21N6M2, 0Kh18G8N2T, and 0Kh21N6B; these are substitutes for brands Kh18N10T and Kh17N13M2T. High-alloy steels 0Kh23N28M3D3T and 000Kh23N28M3D3T are for mediums which are highly corrosive and 000Kh21N21M4B is resistant, under industrial conditions, to wet-process phosphoric acid containing fluorine compounds. Alloys based on nickel–molybdenum (N70M27F) and on chromium–nickel–molybdenum (Kh15N65M16V), are stable with respect to hydrochloric and sulfuric acids, chlorine-containing organic derivatives, and to other corrosive mediums, and have a high resistance to intercrystalline corrosion. (auth)

12593 INFLUENCE OF OXIDIZING AGENTS ON THE CORROSION AND ELECTROCHEMICAL BEHAVIOR OF THE NICKEL–MOLYBDENUM ALLOY EP-496 IN HYDROCHLORIC ACID. Kashcheeva, T. P.; Dubikhina, V. S.; Gadasina, L. Yu.; Meshcheryakova, I. D.; Rutkovskii, M. L. Prot. Metals (USSR) (Engl. Transl.); 7: No. 1, 6-9(Jan-Feb 1971).

Translated from Zashch. Metal.; 7: No. 1, 11-15(Jan-Feb 1971).

The influence of oxygen and Fe^{3+} ions on the corrosion and electrochemical behavior of the alloy ÉP-496 in 22% HCl was studied at 20 and 100°C. It was established that the rate of corrosion of the alloy is determined by the concentration of the depolarizer and by the rate of its delivery to the corroding surface. (auth)

12594 SOME FEATURES OF METAL CORROSION IN DISTILLED WATER AT 250°C. Byalobzheskii, A. V.; Anurova, G. M. (Inst. of Physical Chemistry, Moscow). Prot. Metals (USSR) (Engl. Transl.); 7: No. 2, 91-5(Mar-Apr 1971).

Translated from Zashch. Metal.; 7: No. 2, 112-17(Mar-Apr 1971).

Chromatographic, gravimetric, and x-ray structural methods were used in the investigations into the corrosion behavior of several metals and alloys in distilled water at 250°C. All tested metals, even platinum, underwent corrosion which in nearly all cases was accompanied by evolution of small quantities of hydrogen. The main corrosion process apparently involves the formation of oxide or hydroxide film which is subsequently destroyed by electrolysis. Equations are suggested for calculating the amount of dissolved metal, and of the metal remaining in the oxide film for a case where the amount of absorbed oxygen and the film composition are known. (auth)

12595 OXIDATION OF MAGNESIUM AND METALLO-CERAMIC MAGNESIUM–BERYLLIUM ALLOYS IN CARBON DIOXIDE UNDER A PRESSURE OF 60 atm. Zelenskii, V. F.; Petel'guzov, I. A.; Sulimov, N. A. (Physical-Technical Inst., Kharkov). Prot. Metals (USSR) (Engl. Transl.); 7: No. 2, 107-10(Mar-Apr 1971).

Translated from Zashch. Metal.; 7: No. 2, 132-6(Mar-Apr 1971).

The heat resistance (oxidation resistance) of magnesium and metalloceramic magnesium–beryllium alloys (containing 0.5 to 5% Be) in carbon dioxide of various degrees of humidity is considered at temperatures of 470 to 580°C under a pressure of 60 atm. In carbon dioxide containing more than 0.5 to 1.0% H_2O, magnesium and Mg–Be alloys rupture as a result of the development of intercrystallite and intracrystallite oxidation and also an increase in dimensions, due to the penetration of hydrogen into the structure of the metal or alloy. In the presence of underlayers composed of metals strongly absorbing hydrogen, the heat resistance of magnesium and Mg–Be alloys in moist CO_2 increases. (auth)

12596 MECHANISM OF INHIBITION OF CORROSION ON SEVERAL METALS BY AMINOCHROMATES. Ivanov, E. S. (Moscow State Pedagogical Inst.). Prot. Metals (USSR) (Engl. Transl.); 7: No. 2, 164-5(Mar-Apr 1971).

Translated from Zashch. Metal.; 7: No. 2, 193-4(Mar-Apr 1971).

Results of an investigation of aminochromate concentration effects on adsorption of this compound by metals are presented. Mechanisms by which aminochromates act as metal corrosion inhibitors are discussed. (J.R.D.)

12597 COMPOSITION OF THE FILMS FORMED ON METALS IN DISTILLED WATER AT 250°C. Byalobzheskii, A. V.; Plavnik, G. M.; Anurova, G. M.; Fedorova, G. M. (Inst. of Physical Chemistry, Moscow). Prot. Metals (USSR) (Engl. Transl.); 7: No. 2, 148-9(Mar-Apr 1971).

Translated from Zashch. Metal.; 7: No. 2, 177-8(Mar-Apr 1971).

Results of x-ray-diffraction analysis of films formed on Cu, Cd, W, Mo, Nb, Zr, Ti, Ni, and Fe in distilled water at 250°C are presented. Film compositions as determined by diffraction patterns are described. (J.R.D.)

12598 CORROSION RESISTANCE OF Ti–V–O AND Ti–V–Al–O ALLOYS. Gurevich, S. M.; Kornilov, I. I.; Vavilova, V. V.; (and others) (Inst. of Metallurgy, Moscow). Prot. Metals (USSR) (Engl. Transl.); 7: No. 2, 129-30(Mar-Apr 1971).

Translated from Zashch. Metal.; 7: No. 2, 159-60(Mar-Apr 1971).

The corrosion resistance of titanium-base alloys was investigated in 5% HCl at 50°C, 60% H_2SO_4 at 50°C, boiling 98% acetic acid, and boiling 98% formic acid. Results of 100-hr tests are presented tabularly. (J.R.D.)

12599 OBSERVATIONS ON THE SULPHIDATION BEHAVIOUR OF SOME CHROMIUM-BASED ALLOYS IN HYDROGEN/HYDROGEN SULPHIDE ATMOSPHERE AT 1000°C. Strafford, K. N.; Hampton, A. F. (Newcastle upon Tyne Polytechnic, Eng.). J. Less-Common Metals; 25: No. 4, 435-9(Dec 1971).

Observations of sulfidation behavior of a number of high-purity binary Cr-base alloys containing various quantities of Mo, Ta, V, Zr, or Y are summarized. (J.R.D.)

12600 COMPARATIVE CORROSION TESTS OF ZINC AND CADMIUM COATINGS. Kudryavtseva, I. D.; Lipkina, L. A.;

Skalozubov, M. F.; Yurinskaya, L. V. (Novocherkassk Polytechnic Inst., USSR). Prot. Metals (USSR) (Engl. Transl.); 7: No. 1, 53-5(Jan-Feb 1971).

Translated from Zashch. Metal.; 7: No. 1, 63-6(Jan-Feb 1971)

Results of corrosion testing of these coatings in a simulated tropical climate with periodic immersion in NaCl solutions are presented. The corrosion stability of the coatings was evaluated visually by the presence of blemishes on the coatings and base metals. (J.R.D.)

12601 STUDY OF THE STRESS FISSURATION OF AN AUSTENITIC STAINLESS STEEL CONTAINING 20 PER CENT Cr, 25 PER CENT Ni, AND ADDITIONS OF Mo AND Cu, IN A BOILING SULFURIC MEDIUM. Otter, Claude; Mahieu, Claude; Coriou, Henri (CEN, Fontenay-aux-Roses, France). Compt. Rend., Ser. C; 273: No. 16, 939-42(18 Oct 1971). (In French).

The corrosion resistance under stress of a stainless austenitic type steel containing 20% Cr, 25% Ni, and additions of Mo and Cu in a boiling sulfuric medium was studied. It was found that transgranular fissuration occurs within a restricted range of potentials and that it is not due to embrittlement by hydrogen. (France)

Preparation and Fabrication

Refer also to abstracts 11916, 11919, 11994–11998, 12009, and 13425.

12602 SIGNIFICANCE OF GAS-METAL REACTIONS FOR PURIFICATION AND UTILIZATION OF HIGH-MELTING-POINT METALS. Steinheil, Eckart; Hoerz, Gerhard; Fromm, Eckehard. Forsch. Ingenieurw.; 37: No. 4, 101-8(1971). (In German).

At the high-melting-points of the VA and the VIA elements, gas is absorbed interstitially as a solution. As a consequence, marked changes occur in both mechanical and physical properties of the metals. Processes occurring during uptake and release of gases are discussed. Also considered are property changes of metals through dissolved gases, kinetics of gas uptake and release, and relations for the calculation of thermodynamic equilibria and stationary conditions. Included are the metals V, Nb, Ta, Mo, W, and the gases N_2, O_2, H_2, H_2O, CO, and CH_4. With several examples, the practical significance of gas-metal reactions is demonstrated. (tr-auth)

12603 EFFECT OF COMPOSITION AND CASTING TECHNIQUE ON THE WEAR RESISTANCE OF ABRASIVE-BLASTING MACHINERY. Tvrdy, Miroslav; Eberl, Jaroslav. Slevarenstvi; 17: No. 11, 455-9(Nov 1969). (In Czech).

The service life of abrasive-blasting machines was studied. The blades were cast from four abrasion-resistant alloys (WCrSb, Cr17Mo2.5, Cr17MoWV and Cr27). The best results were obtained with the alloy Cr27 of eutectic type. By alloying this with B, Zr, and/or Nb, greater abrasion resistance than that of the commonly used alloy CSN 42 2466 is obtained. The alloy is suitable for chill casting. (Metals Abstr.)

12604 MODIFIED DOUBLE-JET ELECTROLYTIC THINNING TECHNIQUE FOR TRANSMISSION ELECTRON MICROSCOPY. Mastenbroek, A.; Hamburg, G. (Reactor Centrum Nederland, Petten, Netherlands). J. Phys., E (London); 5: No. 1, 10-11(Jan 1972).

A simplified double-jet technique was developed for preparing transparent specimens for transmission electron microscopy. This technique makes it possible to limit the production of radioactive waste. In addition it is easy to apply and reliable to produce specimens of high quality. (auth)

12605 DEPLETED URANIUM'S PRESENT AND FUTURE IN NONNUCLEAR APPLICATIONS. Metal Progr.; 101: No. 1, 89-92(Jan 1972).

Uranium metal, its alloys, and compounds are now used for ballast and counterweights, radiation shielding, artillery projectiles, and catalysts. Potential applications include vibration damping, centrifugal clutches, and as an alloying element in steel. (auth)

12606 ELECTROTRANSPORT OF IMPURITIES IN RARE-EARTH METALS, USING A PULSED CURRENT. Marchant, J. D.; Shedd, E. S.; Henrie, T. A.; Wong, M. M. Rep. Invest. No. 7480. Washington, D. C.; Bureau of Mines (1971). 13p.

The results of studies on Ce, La, and Pr using a pulsed current were compared with those using a steady current. Impurities that showed appreciable movement with the pulsed current, but not with the steady current, consisted of Mo and O in Ce, Al, Fe and Mo in La. The use of a pulsed current enhances the practical application of solid-state electrotransport to remove a wider variety of impurities from the host metals. (Metals Abstr.)

12607 PRODUCTION OF FERRO-NIOBIUM. Mehra, O. K. (Bhabha Atomic Research Centre, Trombay, India); Taneja, A. K.; Gupta, C. K.; Jena, P. K. Trans. Indian Inst. Metals; 24: No. 1, 66-70(Mar 1971).

Ferro-niobium has been produced both from Indian niobite-tantalite ore and niobium oxide concentrates (obtained as a by-product from tantalum separation) by aluminothermic reduction adopting closed bomb and open reactor techniques. In the closed bomb tests (up to 1 kg scale) with the incorporation of chemical triggers like Ca-S, Al-BaO_2, Mg-$KClO_3$, the aluminothermic reduction was initiated by external heating to a temperature of about 900°C. In the open thermit reduction tests (up to 10 kg scale), on the other hand, the reaction has been initiated by top priming the Mg-BaO_2 combination without external heating. In both cases, the alloy has been obtained in high yields (over 85%) well consolidated and with clean separation from the slag. For larger scale reductions, it would be simpler and less hazardous to adopt internal priming in preference to external heating. (auth)

12608 PREPARATION OF TANTALUM BY FLUORIDE ELECTROLYSIS. Kamat, G. R.; Mukherjee, T. K.; Gupta, C. K. (Bhabha Atomic Research Centre, Trombay, India). Trans. Indian Inst. Metals; 24: No. 1, 55-60(Mar 1971).

The results of a laboratory-scale investigation on the electrolysis of K_2TaF_7 in a KCl-NaCl eutectic bath are presented. The electrolytic cell design capable of producing about ½ lb of tantalum metal powder per batch and the process conditions are described. The influence of current density, bath composition, and temperature on current efficiency has been examined. With a bath comprising NaCl-KCl eutectic with 25% K_2TaF_7, electrolyzed at a current density of 75 A/dm^2 at 750°C, a maximum current efficiency of 81% has been achieved. In a large scale test, electrolyzing for 254 ampere hours a 2-kg fused bath containing 500 g of K_2TaF_7 metal powder yield and current efficiency have been 92% and 70% respectively. Electrolytic tantalum powder has subsequently been consolidated and purified by electron-beam melting and the resulting electron-beam-cast tantalum showing hardness of about 74 DPH has also been cold-worked to strips easily. (auth)

12609 PROCESS FOR COATING NIOBIUM WITH COPPER OR VICE VERSA. (to Siemens Aktiengesellschaft). British Patent 1,258,540. 30 Dec 1971. Priority date 29 Mar 1969, Germany.

A method is described for coating Nb with Cu or vice versa, wherein a metallically pure Nb surface is brought into contact with Cu which is metallically pure at least on its surface. The Cu is united with Nb by heating the Nb to a temperature in the range of 800 to 2500°C under a vacuum with a residual gas pressure of at most 10^{-6} m Hg. (P.C.H.)

12610 INVESTIGATION OF CRITICAL CONDITIONS FOR DEPOSITION OF MOLYBDENUM BY THERMAL DECOMPOSITION OF $MoCl_5$. Richter, W.; Weise, G. (Institut fuer Festkoerperphysik und Werkstofforschung, Dresden). pp 495-9 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

The argon flow method was used to establish the critical conditions for deposition on, or removal of molybdenum from, a hot molybdenum filament in relation to the molybdenum(V) chloride pressure between 1,500 and 2,000°C. At any temperature there exists a limiting $MoCl_5$ pressure below which molybdenum will be deposited from $MoCl_5(g)$ by the reaction Mo + 5Cl (g) $\rightleftharpoons$ $MoCl_5(g)$ and above which it will be removed from the hot filament by the reaction $4MoCl_5(g) + Mo \rightleftharpoons 5MoCl_4(g)$. The experimental limiting pressures were in good agreement with the values calculated from the thermodynamic standard data. (auth)

12611 INTERACTION OF AN Ni–Cr–Si–B COATING WITH STEEL DURING BUILDING-UP BY WELDING. Antonova, E. A.; Andrushchenko, N. S.; Sinai, L. M. (Inst. of Silicate Chemistry, Moscow). Prot. Metals (USSR) (Engl. Transl.); 7: No. 2, 111-15 (Mar-Apr 1971).

Translated from Zashch. Metal.; 7: No. 2, 137-42(Mar-Apr 1971).

The results of a study of protective coating formation on alloy and carbon steels are presented. The coatings are based on finely dispersed Ni–Cr–Si–B powders. The formation of coatings from mixtures of finely dispersed powders, applied to the surface of the metal being protected, was investigated along with the conditions of coating formation. (auth)

12612 METHOD OF GROWING SINGLE CRYSTAL CADMIUM TUBES FROM THE MELT. Ruehlicke, Dieter (Berg-

akademie, Freiberg, Ger.). Prakt. Metallog.; 8: No. 11, 635-40(Nov 1971). (In German and English).

A method is described for growing cadmium single crystal tubes by the Bridgman method. In addition, the necessary details are given for the final treatment of the single crystals. The crucible arrangement chosen should be generally applicable for preparing single crystal tubes of medium melting point metals. (auth)

12613 PRODUCTION OF NIOBIUM COATINGS FROM CHLORIDE MELTS. Krasil'nikov, M. T.; Ivanovskii, L. E. (Inst. of Electrochemistry, Sverdlovsk, USSR). Prot. Metals (USSR) (Engl. Transl.); 7: No. 1, 49-50(Jan-Feb 1971).

Translated from Zashch. Metal.; 7: No. 1, 59-61(Jan-Feb 1971).

Results of experiments are described in which substrates were coated with Nb by electrodeposition from $KCl-NaCl-NbCl_3$ melts at 700 to 750°C. The deposits were annealed at low pressure at 950°C for 5 hr to improve cohesion of the coating and the substrate. (J.R.D.)

12614 FERRITIC ALLOYS. (to Centre National de Recherches Metallurgiques). British Patent 1,253,006. 10 Nov 1971. Priority date 14 Feb 1969, Luxembourg.

An iron-base fuel cladding alloy for use at ~700°C is described. The alloy is composed of Cr-13 to 25 wt %, Ti-2 to 7 wt %, and at least one metal selected from a group including Al-0 to 6 wt %, V-2 to 7 wt %, Si-2 to 7 wt %, Mo-0 to 3 wt %, and one or more rare earths at 0 to 0.5 wt % per rare earth. The balance other than incidental impurities is Fe. (J.R.D.)

Properties Evaluations

Refer also to abstracts 11983, 13434, 13435, 13447, 13448, 13452, 14503, and 14504.

12615 (HEDL-TME-71-145) HIGH STRAIN RATE MECHANICAL PROPERTIES OF TYPE 304 STAINLESS STEEL AND NICKEL 200 (RM-14). Steichen, J. M. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1971. Contract AT(45-1)-2170. 25p. Dep. NTIS.

The effect of strain rate on the mechanical properties of solution annealed 304 stainless steel at room temperature and 1000°F and annealed Nickel 200 at room temperature was determined. Strain rates employed in this evaluation ranged from the normal tensile rate (3×10^{-5} in/in/sec) to high strain rates (1×10^{2} in/in/sec) associated with hypothetical core disruptive accidents. The results show the deformation behavior of both Nickel 200 at room temperature and 304 stainless steel at room temperature is similar to that of 304 stainless steel at 1000°F; however, the room temperature deformation behavior of Nickel 200 appears to more accurately represent the 1000°F deformation behavior of 304 stainless steel than does the room temperature deformation behavior of 304 stainless steel. General observations from the results of the tests on 304 stainless steel and Nickel 200 are as follows: the ultimate and 0.2% yield stress of Nickel 200 at room temperature and 304 stainless steel at 1000°F are significantly lower than those of 304 stainless steel at room temperature. The strain rate dependence of the stress values appears to be similar between the various materials; the total and uniform elongation of Nickel 200 at room temperature and 304 stainless steel at 1000°F remain constant with increasing strain rate and are significantly lower than the total and uniform elongation of 304 stainless steel at room temperature which decreases with strain rate; Nickel 200 at room temperature exhibits higher reduction of area values than 304 stainless steel at room temperature and 1000°F; and the true stress-strain behavior of Nickel 200 at room temperature is almost identical to that of 304 stainless steel at 1000°F. (auth)

12616 (HEDL-TME-71-164) HIGH STRAIN RATE MECHANICAL PROPERTIES OF TYPES 304 AND 316 STAINLESS STEEL (RM-17). Steichen, J. M. (Hanford Engineering Development Lab., Richland, Wash.). Nov 1971. Contract AT(45-1)-2170. 49p. Dep. NTIS.

The effect of strain rate on the mechanical properties of solution annealed 304 and 20% cold worked 316 stainless steels was determined at temperatures from 600 to 1600°F. Strain rates employed in this evaluation ranged from the normal tensile rate (3×10^{-5} in/in/sec) to high strain rates (1×10^{2} in/in/sec) associated with incident conditions. The results show the deformation behavior of both materials is significantly influenced by strain rate and that excellent strength and ductility can be expected from both materials in the unirradiated condition at strain rates and temperatures associated with accident conditions. Solution annealed 304 and 20% cold worked 316 stainless steels appear to behave very similarly over the strain rate and temperature range of this study; hence, cold work does not appear to greatly alter the strain rate dependence of austenitic stainless steels. General trends observed for both materials are as follows: the engineering and true ultimate stress of both materials are relatively insensitive to strain rate at temperatures to 1000°F. At temperatures of 1200, 1400, and 1600°F, the ultimate stress of both materials increases significantly with increasing strain rate; the 0.2% yield stress of both materials increases in varying amounts with strain rate at all test temperatures; the total elongation of both materials is relatively insensitive to strain rate at temperatures of 1000°F. At 1200, 1400, and 1600°F, the effect of strain rate on total elongation becomes complex; overall, the total elongation of 20% cold worked 316 stainless steel is reduced by increasing strain rate, and the total elongation of 304 stainless steel is initially enhanced and then reduced by increasing strain rate; and the uniform elongation of both materials slightly decreases with increasing strain rate at temperatures to 1000°F and increases with strain rate at temperatures of 1200°F and above. (auth)

12617 (LBL-179) PREDICTION OF THE STRESS-STRAIN BEHAVIOR OF POLYCRYSTALLINE α-IRON CONTAINING HARD SPHERICAL PARTICLES. Jones, Russell H. (California Univ., Berkeley. Lawrence Berkeley Lab.). 10 Oct 1971. Contract W-7405-eng-48. 99p. Dep. NTIS.

Thesis.

The stress-strain behavior of polycrystalline α-iron containing hard spherical particles has been predicted using relationships based on particle-dislocation interaction mechanisms. The yielding behavior obeyed a modified Orowan type relationship, as proposed by Ashby. The work hardening rates were in close agreement with the rates predicted by a model based on the generation of secondary dislocations at the particles, also proposed by Ashby. These relationships, which were developed to predict the flow properties of single crystals containing hard particles, were used to predict the flow properties of polycrystals containing hard particles. Alloys with second phase volume fractions of 0.73 to 6.14% and particle diameters of 1250 to 2300 Å were examined. The distribution of the particle diameters and randomness of the particle dispersion were examined with carbon extraction replicas. The volume fraction of second phase was determined with the aid of the electron beam microprobe analyzer. The matrix structure was studied using optical and electron transmission microscopy and the grain orientation randomness was examined using the x-ray Laue back reflection technique. (auth)

12618 (UCRL-51102) WAVE PROPAGATION MODEL FOR IMPULSE PREDICTION. Walton, Otis R. (California Univ., Livermore. Lawrence Radiation Lab.). 30 Jul 1971. Contract W-7405-eng-48. 20p. Dep. NTIS.

Melt-dominated impulse produced by blowoff from a thin region of material that is instantaneously heated above melting may be estimated by considering propagation of the initial stress profile as an acoustic wave in a semi-infinite medium. The time integral of the stress profile as it passes some point is shown to be proportional to the total energy deposited. The constant of proportionality depends only on the depth of material melted and a simple initial shape parameter for depositions near a free surface. If a material with a low relative shock impedance is placed over the heated region, the impulse is the same as for the free-surface case. If a material with a high relative shock impedance is placed over the heated region, the proportionality constant depends only on the relative shock impedance and is independent of melt depth and deposition shape. The model fails when the vapor pressure of the heated material becomes significant. (auth)

12619 (UCRL-51121) GRAY, A THREE-PHASE EQUATION OF STATE FOR METALS. Royce, E. B. (California Univ., Livermore. Lawrence Livermore Lab.). 3 Sep 1971. Contract W-7405-eng-48. 49p. Dep. NTIS.

A three-phase equation of state for metals was developed, based on the following assumptions: the entropy of melting is independent of pressure; the temperature dependence of the specific heat in the liquid is a universal curve, scaled on the melting temperature; the pressure dependence of the melting temperature is given by a modified Lindemann law; and the liquid-vapor region may be described by a hard-sphere model perturbed by a van der Waals attraction. The equation of state is laid out in a P(V, E) form for use in numerical hydrodynamics calculations, and parameters are given for Be, Mg, Al, Ti, stainless steel, Ni, Monel, Cu, Nb, Ta, W, Au, Pb, Th, Mulberry, and U. Experimental evidence for the validity of the equation of state is presented. (auth)

12620 INTERMETALLIC RARE-EARTH COMPOUNDS. Taylor, K. N. R. (Univ. of Durham, Eng.). Advan. Phys.: 20: No. 87, 551-632(Sep 1971).

The physical properties of many of the rare earth intermetallic

compounds were collected together. They are discussed in terms of the role that the magnetic exchange and crystal field interactions play in determining these properties. It is pointed out that in this vast number of materials there is an ideal chance of establishing which of several second-order terms are effective in determining structural stability. (auth)

12621 EFFECT OF ALLOYING WITH TRACES OF TITANIUM AND ZIRCONIUM ON THE PROPERTIES OF NIOBIUM. Prokoshkin, D. A.; Vasil'eva, E. V.; Markova, S. A. Izv. Akad. Nauk SSSR, Metal.; No. 2, 130-5(Mar-Apr 1971). (In Russian).

The microstructure, hardness, and mechanical properties of extruded and annealed Nb containing 1 to 5 at. % of Zr or Ti were studied at room temperature; so were the creep characteristics at 1100°C. Electron probe microanalysis revealed a uniform distribution of Ti throughout the grain, but a tendency of Zr to concentrate at the grain boundaries. The hardness and UTS of the material increased sharply on adding either Ti or Zr; the creep resistance also increased. These effects were attributed to the redistribution of the dislocation structure arising from the intrusion of the alloying additives. (Metals Abstr.)

12622 EFFECT OF CARBON ON THE STRUCTURE AND MECHANICAL PROPERTIES OF TUNGSTEN SINGLE CRYSTALS. Kopetskii, Ch. V.; Orzhekhovskii, V. L.; Pashkovskii, A. I.; Chuzhko, R. K. Izv. Akad. Nauk SSSR, Metal.; No. 2, 124-9 (Mar-Apr 1971). (In Russian).

The structure and mechanical properties of W single crystals with growth axes along the (110) and (100) directions containing 0.01 to 0.001 wt % C were studied at 77 to 500°K. Reducing the C content increased ductility, particularly at low temperature, slightly reduced the temperature-dependence of the YS, and led to a more uniform dislocation distribution, together with an enlargement of the subsidiary grains in the W crystals. The YS, ductility characteristics, and microstructure also depended greatly on the crystallographic direction employed for the tensile tests. (Metals Abstr.)

12623 METHOD FOR MEASUREMENT OF THE FUSION RANGE OF SLAGS. Zalazinskii, M. G.; Knyshev, E. A.; Rubinshtein, E. A. Sb. Tr. Klyuchevsk. Zavoda Ferrosplavov; No. 4, 38-40(1969). (In Russian).

A method is described for the determination of the temperature range for the melting of aluminothermic slags. The method is based on the sharp reduction in electrical conductivity as the system crystallizes. Data are given of results from industrial decarburized Fe–Cr, low-Si Fe–Nb, and Al–Zr melts. (Referativnyi Zh.)

12624 EFFECTS OF INHIBITION ON THE STRUCTURE AND MECHNICAL PROPERTIES OF TANTALUM ELECTRO-DEPOSITED FROM A FUSED-SALT ELECTROLYTE. Graime, Harland Stuart. Hoboken, N. J.; Stevens Inst. of Tech. (1971). 174p. University Microfilms Order No. 72-1615.

Thesis.

The relationships between the plating conditions and the microstructure, polarization, fiber axis and mechanical properties of tantalum electrodeposited from a fused alkali-fluoride bath were investigated. Tantalum was plated onto thin randomly-oriented, polycrystalline copper substrates at current densities of 10, 20, and 50 mA/cm^2 at temperatures of 700 and 800°C. Two different microstructural types were observed. One type was composed of regular crystalline, faceted features and was associated with ⟨110⟩ and ⟨100⟩ preferred orientations as well as a random orientation. The second type of surface microstructure consisted of rounded mounds and was always associated with a random orientation and broadened diffraction rings. These different orientations were found to correspond to different values of the Tafel slope. With increasing polarization the orientation changed from ⟨110⟩ to ⟨100⟩ to random. The increase in polarization and change in orientation was attributed to inhibition resulting from the co-deposition of carbon. The carbon contents of the samples were found to increase with the polarization as the orientation changed from ⟨110⟩ to ⟨100⟩ to random. The internal grain structure of the facet-surface structured deposits was not affected by the deposition conditions. A grain size of 0.5 to 1.5 microns associated with spotty diffraction rings was observed at all plating conditions yielding this surface structure. The rounded-mound surface structured deposits, however, showed no discernible grain structure and diffraction patterns contained only broadened rings. The mechanical properties of tensile strength and ductility were measured using the hydraulic bulge test. The results of the mechanical tests show general relationships between the strength, ductility, and thickness of the deposits. The mechanical properties decreased with increasing current density for samples plated at 700°C while for those plated at 800°C the properties decreased between 10 and 20 mA/cm^2 and increased again at 50 mA/cm^2. (Diss. Abstr. Int., B)

12625 THEORY OF DISPERSION HARDENING IN METALS. Hart, E. W. (General Electric Research and Development Center, Schenectady, N. Y.). Acta Met.; 20: No. 2, 275-89 (Feb 1972).

A quantitative theory is presented to describe the increment of strain hardening due to a dispersed second phase in metals. The theory is a major modification of an earlier one by Fisher et al. In addition to detailed prediction of the hardening increment as a function of strain, the theory is used as the basis for several qualitative predictions. Predictions include an initial fine slip, a constant hardening increment at small strain, and an enhancement of the Bauschinger effect. (auth)

12626 FLOW STRESS OF PARTIALLY ORDERED Ni_8Ta ALLOY SINGLE CRYSTALS. Bradley, E. R.; Polonis, D. H. (Univ. of Washington, Seattle). Scr. Met.; 5: No. 12, 1093-7(Dec 1971).

Flow stress measurements were made on alloy single crystals of composition Ni_8Ta in both the disordered and the partially ordered conditions. Single crystal specimens with an axis orientation favoring one slip system were used. The flow stress values were correlated with both the volume fraction of the ordered phase and the domain size. The results showed that the most important factor determining the flow strength of partially ordered Ni–Ta alloy single crystals is the volume fraction of the ordered phase since maximum strengthening occurred with 60 vol % Ni_8Ta regardless of the size or distribution of the ordered domains. (P.C.H.)

12627 LOW FREQUENCY STUDY OF THE SPECTRUM OF INTERNAL FRICTION OF Zr AND Zr–Hf–O SOLID SOLUTIONS BETWEEN 300 AND 700 DEG C. Gacougnolle, J. L.; Sarrazin, S.; de Fouquet, J. (Ecole Nationale Superieure de Mecanique et d'Aerotechnique, Poitiers, France). J. Phys. (Paris), Colloq.; 71: No. 2, 21-4(1971). (In French).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

The internal friction of refined Zr and Zr-Hf alloys was measured at a frequency of 1 cycle/sec. A grain boundary peak was found at about 570°C. This peak is insensitive to Hf concentration as the activation energy of 69 kcal/mole is much greater than Zr self-diffusion energy (27 kcal/mole). The addition of O to those alloys makes the peak to disappear and a new one to appear at about 420°C. It is due to O atomic jumps as the activation energy is identical to O diffusion energy in Zr (48.5 kcal/mole) and its height is proportional to O concentration. The effect of Hf concentration on the relaxation mechanism is discussed. (France)

12628 INTERNAL FRICTION IN TUNGSTEN CONTAINING CARBON. Gray, R. J.; Szkopiak, Z. C. (Univ. of Surrey, Guildford, Eng.). J. Phys. (Paris), Colloq.; 71: No. 2, 163-7(1971).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

Internal friction in annealed and deformed W was investigated from room temperature to 950°C at a frequency of 1 Hz. The Snoek peak of C was observed at a temperature of 410°C, and another peak at temperatures between 550 and 600°C. The latter peak required the combined presence of C and dislocations, and is not a relaxation peak. It was accounted for in terms of the change in the temperature dependent dislocation damping caused by an irreversible rearrangement of C during recovery. Subsequently, C atoms originating from C clusters or carbide precipitate pin dislocations. The activation energy of the pinning process was determined to be 56 ± 4 kcal · mole^{-1}. (France)

12629 LOW TEMPERATURE INTERNAL FRICTION OF COLD-WORKED ZIRCONIUM. Savino, E. J.; Bisogni, E. A. (Comision Nacional de Energia Atomica, Buenos Aires). J. Phys. (Paris), Colloq.; 71: No. 2, 209-13(1971).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

The low frequency spectrum of internal friction in high-purity Zr was studied using a torsion pendulum, which allowed in situ deformations to be performed either at room temperature or at 78°K. After room temperature deformation an internal friction peak P_1 centered at about 150°K (for 1 Hz) was found. ΔH and τ_0 were obtained by varying the measuring frequency, their measured values are 3 ± 0.4 kcal/mole and $10^{-5\pm1}$ s, respectively. When samples are deformed at liquid nitrogen temperature and internal friction is measured during warm-up, a weak P_1' maximum appears at 130°K and P_{21} and P_{22} peaks also appear between 210 and 230°K. An increase in internal friction and a modulus defect at 80°K were also detected. The results are analyzed in terms of possible sources of energy dissipation in cold-worked metals. (France)

12630 STUDY OF THE INTERNAL FRICTION PEAKS OBSERVED AFTER COLD-WORKING IN Ti AND Zr AT LOW TEM-

PERATURE. Petit, J.; Quintard, M.; Soulet, R.; de Fouquet, J. (Ecole Nationale Superieure de Mecanique et d'Aerotechnique, Poitiers, France). J. Phys. (Paris), Colloq.; 71: No. 2, 215-20 (1971). (In French).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

Internal friction measurements were made at about 20 kHz by longitudinal vibrations in Zr and Ti. Peaks were observed after cold-working between −60 and +50°C. Characteristics and dependence of the decrement on plastic deformation, isochronal annealing, purity of metals, and initial state, were established. (France)

12631 STUDY OF THE INTERNAL FRICTION PEAKS OBSERVED AFTER COLD-WORKING IN b.c.c. METALS (Nb, Mo). Rieu, G.; de Fouquet, J. (Ecole National Superieure de Mecanique et d'Aerotechnique, Poitiers, France). J. Phys. (Paris), Colloq.; 71: No. 2, 221-8(1971). (In French).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

Internal friction relaxation peaks observed after cold-working in bcc metals (especially Nb and Mo) were studied in terms of cold-working parameters such as stress, strain, temperature, and strain rate. The form, the increase, and the annealing of the peaks are similar for Nb and Mo, and the evolution of the P_α and P_β peaks is the same for both metals. The P_α and P_β peaks are explained by the formation of kinks on edge and screw dislocations respectively. (France)

12632 CREEP-RUPTURE STRENGTH OF W COMPOSITE CAST WITH SOME HEAT-RESISTANT ALLOYS. Arai, Takashi; Yoda, Renpei (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 35: No. 11, 1050-5(Nov 1971). (In Japanese).

High-temperature properties of the composite material which was coated with various heat-resistant alloys with a view to using molybdenum at elevated temperatures in air under high stressed conditions have been reported. Studies were made on the use of W as core material to improve the creep-rupture strength. The results showed that tungsten and both heat-resistant alloy melts were bonded by fusion perfectly in air. This material was found capable of being hot-swaged by reducing the reduction per a pass. The creep rupture life was improved considerably by varying the core material from molybdenum to tungsten. A reciprocal relation was obtained between the creep-rupture strength and the secondary creep rate in the temperature range of 1000 to 1200°C. It was also found that the surface oxidation of the coating alloys during creep-rupture testing had no effect on the lifetime at 1000°C. (auth)

12633 STRESS RELAXATION IN ZONE REFINED TUNGSTEN AND QUANTUM MECHANICAL TUNNELING OF DISLOCATIONS. Galligan, J. M. (Brookhaven National Lab., Upton, N. Y.); Oku, T. Acta Met.; 19: No. 3, 223-5(Mar 1971).

Some results of stress relaxation measurements of tungsten crystals are presented. Above a temperature of about 30°K the relaxation follows the typical low-temperature behavior. However, below 30°K the stress relaxation is temperature-independent and time-independent. These results are consistent with quantum mechanical tunneling of dislocations. (auth)

12634 FATIGUE AND CRACK PROPAGATION BEHAVIOR IN Ti-6Al-6V-2Sn. Amateau, M. F.; Kendall, E. G. Technical Report No. W71-22.5. Metals Park, Ohio; American Society for Metals (1971). 12p. $3.00.

The S-N fatigue behavior of Ti-6Al-6V-2Sn alloy for a number of different material forms and conditions is reviewed. A comparison is made of the fatigue strength of sheet, plate, extrusions, and forgings in both the mill-annealed and solution treated and aged conditions. The effects of O content, heat treatment, and processing temperature on S-N behavior are illustrated from the literature. The effect of test temperature on fatigue life is also reviewed. Experimental results from crack growth studies in Ti-6Al-6V-2Sn using contoured double cantilever beam specimens are also presented. The crack growth rates have been determined at room temperature in environments of dry air, laboratory air, distilled water, and 3.5% water. Crack growth behavior of both α processed and α/β processed material is compared. (Metals Abstr.)

12635 FLOW STRESS OF NIOBIUM–OXYGEN AND NIOBIUM–NITROGEN ALLOYS. Szkopiak, Z. C. (Univ. of Surrey, Guildford, Eng.). J. Less-Common Metals; 26: No. 1, 9-17(Jan 1972).

The effects of oxygen and nitrogen concentration on the room temperature flow stress of niobium have been studied at strain rates from 5×10^{-5} to 2×10^{-1} sec^{-1}. The flow stress increased linearly with increasing solute content. The solution-hardening coefficients (α) for both oxygen and nitrogen were strain-rate independent, but varied with plastic strain (ϵ) according to the equation $\alpha = A\epsilon^a$, where A and α had different values for each solute. As in the case of hardness and yield stress, nitrogen was twice as effective as oxygen as a solution hardener. The factor of two decreased with increasing plastic strain. Over the interstitial solute concentration range for direct solution hardening the dislocation velocity exponent (m'), as calculated from the strain rate dependence of flow stress using the equation $\log \sigma = \log B + (1/m') \log \dot{\epsilon}$, varied with plastic strain and oxygen and nitrogen concentrations. (auth)

12636 INTERSTITIAL SOLUTE PICK-UP IN ANNEALED NIOBIUM AND THE HALL–PETCH PLOT. Szkopiak, Z. C. (Univ. of Surrey, Guildford, Eng.). J. Less-Common Metals; 26: No. 1, 19-24(Jan 1972).

The Hall–Petch k_y parameter for niobium is briefly reviewed and the anomalous variation in its reported values is discussed. Results are presented showing the variation of oxygen and nitrogen contents during annealing of niobium, and its effect on the k_y parameter. The main effect of pick-up of oxygen and/or nitrogen during annealing is to increase the yield stress of the coarse-grain specimens, and hence to reduce the k_y parameter appreciably, or even to zero. (auth)

12637 DIFFUSION OF ^{14}C IN TUNGSTEN AND TUNGSTEN–RHENIUM ALLOYS. Shepela, Adam (Cornell Univ., Ithaca, N. Y.). J. Less-Common Metals; 26: No. 1, 33-43(Jan 1972).

The diffusion coefficients of the radioactive tracer, carbon-14, in randomly-oriented single crystals of tungsten and tungsten–rhenium alloys (3.9 at. % Re, 6.8 at. % Re) have been measured over the temperature range 1500 to 1800°C: $D(^{14}C/W) = (3.45 \pm 0.12)10^{-3} \exp(-37{,}800 \pm 140/RT)$ cm^2/sec; $D(^{14}C/W - 3.9$ at. % Re$) = (3.00 \pm 0.26)10^{-3} \exp(-37{,}000 \pm 330/RT)$ cm^2/sec; and $D(^{14}C/W - 6.8$ at. % Re$) = (2.24 \pm 0.09)10^{-3} \exp(-36{,}100 \pm 170/RT)$ cm^2/sec. The values for the activation energy, Q, and frequency factor, D_0, for carbon-14 in tungsten agreed well with the values determined by Kovenskii over the range 1800 to 2800°C. Experimentally, a thin carbide layer, formed on one face of the sample by a reaction with carbon-14 (fine powder, 10 mc/mM), provided the source of carbon throughout the diffusion anneal. Since a non-equilibrium redistribution of carbon occurred during cooling, the concentration profile within 60 μm of the interface, measured at room temperature, was different from that established during the diffusion anneal. Therefore, a computer iteration technique was used to calculate a best-fit value for D, the diffusion coefficient, from the measured values of the activity, A(x); the distance from the carbide–solid solution interface, x; the annealing time, t, and from the estimated values of the activity at the interface, A_L. In all diffusion samples, a zone of carbon depletion adjacent to the interface was observed as a result of carbon segregation to the interface. The extent of the depleted zone was a function of cooling rate. The driving force for the interface enrichment effect was the supersaturation of the solid solution with carbon as the sample temperature was decreased. (auth)

12638 OXIDATION BEHAVIOR OF A NIOBIUM (COLUMBIUM) ALLOY, ^{132}Cb. Felten, Edward J. (United Aircraft Corp., Middletown, Conn.). J. Less-Common Metals; 26: No. 1, 105-15(Jan 1972).

The oxidation behavior of the niobium alloy, Nb-132 (Nb–20Ta–15W–5Mo wt %), has been examined in the temperature range 550 to 1316°C. Between 550 and 650°C, dissolution of oxygen without the formation of a significant amount of surface scale was observed. Between 650 and 900°C, Nb-132 oxidized by way of a two-stage process. Initially, oxidation occurred at a slow rate, followed by a more rapid and linear rate. Both the transition time from the initial to the steady state and the linear rate constants obeyed an Arrhenius relationship. The surface scale formed in this temperature range was voluminous and non-adherent. Above 900°C, the weight change curves obeyed the parabolic rate law over a considerable portion of their length. The oxide scale was dense, adherent, and similar in composition to the base metal. Oxidation proceeded by the diffusion of oxygen through the initially-formed oxide layer above 900°C. Below this temperature, grain boundary diffusion of oxygen was presumed to be the rate controlling process. (auth)

12639 CHROMIUM ALLOY CONTAINING ZIRCONIUM, NIOBIUM, AND CARBON: STRESS-RUPTURE PROPERTIES AND THE CONTROL OF DUCTILITY BY MODIFICATION OF MICROSTRUCTURE. Miles, D. E.; Rogers, J. A. (National Physical Lab., Teddington, Eng.). J. Less-Common Metals; 26: No. 1, 127-38(Jan 1972).

A Cr–0.7Zr–1.0Nb–0.037C alloy was found to have high temperature properties superior to those of similar Cr–Zr–C alloys. The stress to rupture at 1050°C in 100 hr was 92.7 N/mm^2 (6 tsi)

compared with 42.5 N/mm^2 (2.75 tsi) for similar alloys in the Cr–Zr–C system and 66.4 N/mm^2 (4.3 tsi) for the strongest alloy in that system. The ductile-to-brittle transition temperature was high when determined in a bulge test but was 200°C lower following a thermal and mechanical treatment. The reduction of the transition temperature was accompanied by the modification of the lath-like intermetallic precipitate $(Zr,Nb)Cr_2$ to a spheroidal form. The precipitate was stable at possible service temperatures. The lower transition temperature obtained when the intermetallic precipitate was present appeared to be due to the influence of particles on the deformation process rather than to a retained dislocation arrangement or to a grain size effect. Finer carbide particles were obtained in the Cr–Zr–Nb–C alloy than in the Cr–Zr–C alloys and their size could be further reduced to about 35 nm dia by deformation. The transition temperature of the Cr–Zr–Nb–C alloy was significantly lower after deformation. (auth)

12640 PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON CALORIMETRY AND THERMODYNAMICS, WARSAW, AUGUST 31–SEPTEMBER 4, 1969. Warsaw; Polish Scientific Publishers (1969). 1138p. (CONF-690834).

One-hundred-forty-five articles are included; separate abstracts were prepared for 16. Two of the articles on thermodynamic activity of Ca on liquid Sn–Ca and Be–Ca alloys and thermodynamic study of the Be–Al system were previously included in NSA as 24: 32437 and 32436, respectively. Five articles on the life and scientific activity of Wojciech Swietoslawski are also included. The remaining 127 articles contain information on calorimetric techniques and apparatus, calorimetry of non-reacting systems; reaction calorimetry; adsorption studies; vaporization studies in inorganic systems; thermodynamics of simple fluids; thermodynamics of gases and gas mixtures; thermodynamics of liquid non-aqueous non-electrolyte mixtures; thermodynamics of aqueous electrolyte solutions; thermodynamics of alloys and molten salt systems; and thermodynamics of systems of biochemical interest. (P.C.H.)

For abstracts of individual papers see: 11660, 12610, 12641–12646, and 12754–12761.

12641 EXPERIMENTAL DETECTION OF AN ANOMALY IN THE SPECIFIC HEAT OF A METAL WITH NONMAGNETIC HEAVY IMPURITY ATOMS. Panova, G. Kh.; Samoilov, B. N. (Inst. of Atomic Energy, Moscow). pp 191-5 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

Studies were made on the quasi-local level in the vibrational spectrum of the lattice of alloys with heavy impurity atoms by measuring the low-temperature heat capacity. Data are given on the quasi-local level in the vibrational spectrum of the Mg lattice with an admixture of 2.8 at. % Pb and of the Ti lattice with an admixture of 5 at. % U. It was found that the influence of the quasi-local level on the heat capacity can be most clearly seen if the temperature dependence of the relative heat capacity change, $\Delta C/C$, where ΔC is the difference between the phonon heat capacities of the alloy and of the host metal (C). A plot of the capacity change against T over the range 1.2 to 20°K indicated the existence of a pronounced anomaly in the heat capacity of crystals with heavy impurity atoms for MgPb at 10.6°K and for TiU at 12°K. The heat capacity of the MgPb alloy was 2 times and the TiU 2.7 times that of pure Mg and Ti at the maximum. The results confirmed the theoretically predicted strong deformation of the low frequency part of the phonon spectrum in the crystals associated with introduction of heavy impurity atoms and may serve as indirect proof of the existence of quasi-local frequencies in MgPb and TiU alloys. (P.C.H.)

12642 MOLYBDENUM AS A STANDARD REFERENCE SUBSTANCE IN HIGH TEMPERATURE CALORIMETRY. Chekhovskoi, V. Ya.; Petrov, V. A. (Inst. for High Temperature, Moscow). pp 219-22 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

On the basis of the recent most accurate measurement of molybdenum enthalpy within a temperature range of 1,000 to 2,850°K, carried out in this Laboratory, as well as on its enthalpy and specific heat data obtained by others, the use of molybdenum as a standard reference substance in high-temperature calorimetry is recommended. The accuracy of the recommended data on enthalpy and specific heat within the temperature range 1,000 to 2,300°K is equal to ±0.4 and ±1.0%, respectively. (auth)

12643 THERMODYNAMIC STUDY OF GASEOUS RARE EARTH AURIDES. Gingerich, K. A.; Finkbeiner, H. C. (Texas A and M Univ., College Station). pp 457-61 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

The gaseous equilibria of LnAu + Au = Ln + Au_2, where Ln is either La, Ce, Pr, or Nd, were studied by means of Knudsen-effusion, high-temperature mass spectrometry using both second and third law methods. Second law reaction enthalpies, ΔH_T, were obtained for the same four rare earth elements, and dissociation energies of all rare earth aurides were calculated. The calculated values for the bond energies of the rare earth aurides were all rather high and varied between 2.7 and 3.6 eV. They were estimated to be uncertain to ±0.3 eV for ScAu and YAu. (P.C.H.)

12644 CALORIMETRIC OBSERVATION OF LOCALIZED VIBRATIONAL STATES IN Mg–Cd ALLOYS. Johnston, W. V.; Lehman, G. W.; Wooten, W. W. (North American Rockwell Corp., Thousand Oaks, Calif.). pp 995-1001 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

Heat capacity measurements were extended to higher temperatures and to higher concentrations of Cd in Mg than previously in order to observe the peak in the ΔC_p predicted by the Lehman–DeWames theory and to provide a broader experimental region over which to compare the predictions of the existing theories. The results showed that at concentrations of Cd above 2% the increase in heat capacity with additional Cd additions was less than linear, and became increasingly so with increase in temperature. As a first approximation the $C_p - C_v$ correction for the alloys was assumed to be the same as for pure Mg. Some justification for this was found in the high temperature convergence of the ΔC_p. (P.C.H.)

12645 THERMODYNAMIC PROPERTIES OF SOLID PALLADIUM–CADMIUM ALLOYS. Darby, J. B. Jr. (Argonne National Lab., Ill.); Myles, K. M.; Pratt, J. N. pp 1021-6 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

The integral free energy, the integral enthalpy, and the integral entropy of formation were determined for a series of palladium-rich palladium–cadmium alloys. The activities and free energy values at 1350 K were calculated from the vapor pressure of cadmium over the alloys. The enthalpy values were determined from heat-of-solution data obtained by means of a liquid-metal solution calorimeter. Various possible contributions to the thermodynamic quantities are considered; the dominant contribution to the enthalpy was derived from the filling of the d-band of palladium by the s-electrons of cadmium. (auth)

12646 THERMODYNAMIC STUDIES ON REFRACTORY METAL ALLOYS BY THE e.m.f. METHOD WITH SOLID ELECTROLYTES AT HIGH TEMPERATURES. Rezukhina, T. N.; Drobishev, V. N.; Kravchenko, L. I.; Pokarev, P. (Moscow State Univ.). pp 1033-41 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

In order to secure a reliable equilibrium in studies on the thermodynamic properties of refractory metal alloys, the experiments were run for long periods of time and at high temperatures, viz., for 15 to 20 days at 1200 to 1400°K with the 0^{2-} electrolytes and for 5 to 10 days at 1000 to 1200°K with the CaF_2 electrolyte. Thermodynamic data on the Mo–Co, Nb–Co, Nb–Fe, Ta–Fe, Ta–Co, and Y–Re alloys are given. In the Nb–Fe, Nb–Co, Ta–Fe, Ta–Co, and Y–Re systems the emf cell method was used to measure the thermodynamic properties of the Laves phases: $NbFe_2$, $NbCo_2$, $TaFe_2$, $TaCo_2$, and YRe_2. As compared with other intermetallic compounds with interacting constituents predominantly metallic nature, the resulting Laves phases were characterized by very large negative values of ΔG and ΔH. (P.C.H.)

12647 DIFFUSION DATA. VOLUME 5, NUMBER 3, 1971. Woehlbier, F. H. (ed.). Diffus. Data; 5: No. 3, 429-583(1971).

Data are presented on diffusion in solid metals and alloys, liquid metals and alloys, semiconductors, oxide systems, halides, carbides, hydrides, nitrates, and organic crystals. References (131) to the above material plus additional references and book reviews are also cited. Separate indexes are included for author, host substance, and phenomenological topic. (P.C.H.)

12648 INFLUENCE OF AGING TIME AND TEMPERATURE ON THE SUSCEPTIBILITY OF γ-QUENCHED U–5 WT PERCENT

Nb ALLOY TO SCC. McLaughlin, B. D.; Stephenson, L. L.; Miglionico, C. J. (Sandia Labs., Albuquerque, N. Mex.). Corrosion; 28: No. 1, 35-8(Jan 1972).

In regard to stress corrosion cracking (SCC) susceptibility of U–5 wt % Nb alloy, studies were made on the incubation time and fracture mode as pronounced functions of thermal history for this alloy. The results showed that optimum resistance to the initiation of stress corrosion cracks, can be obtained, in a reasonable time, only by aging above 550°C. High temperature aging produced a material with reasonable tensile and ductility properties. A wire specimen aged for 8 hr at 600°C possessed an ultimate tensile strength of 160 ksi with 17% elongation. (P.C.H.)

12649 EFFECT OF SUBSTITUTIONAL DYNAMIC STRAIN AGEING ON THE MECHANICAL BEHAVIOR OF AN IRON–1.1 AT. PERCENT NIOBIUM ALLOY. Winstone, M. R.; Rawlings, R. D. (Imperial Coll. of Science and Tech., London). Phys. Status Solidi (a); 8: No. 1, 79-85(16 Nov 1971).

The tensile properties of a solution-treated Fe–1.1 at. % Nb alloy were studied in the temperature range 300 to 860°K at a strain rate of 8×10^{-5} sec^{-1}. Dynamic strain aging (DSA) occurs between 660 and 780°K and is considered to be the consequence of a strong elastic-misfit interaction between the niobium atoms and the dislocations. The DSA is associated with a reduction in ductility, which is attributed to an increase in the rate of work-hardening and strain rate effects in the necked region of a specimen. Constant-load creep tests show that DSA enhances the creep resistance of Fe–Nb alloys, particularly below 825°K, when the deformation is effectively athermal. At higher temperatures the apparent activation energy for creep was 4.5 eV, in good agreement with other work on iron and iron-based alloys. (auth)

12650 THERMOTRANSPORT OF NITROGEN AND OXYGEN IN β-ZIRCONIUM. Vogel, D. L.; Rieck, G. D. (Eindhoven Univ. of Tech., Netherlands). Acta Met.; 19: No. 3, 233-45(Mar 1971).

An investigation of thermotransport of nitrogen in β-zirconium is reported. Using a method previously described, the heat of transport turned out to be 25.1 kcal/mole with a standard deviation of 2.5 kcal/mole. The formerly published value of the heat of transport of oxygen in β-zirconium, viz., 20 kcal/mole (standard deviation 2 kcal/mole) has been readjusted to 21.3 kcal/mole (standard deviation 2.9 kcal/mole). (auth)

12651 THERMOTRANSPORT OF OXYGEN AND NITROGEN IN TITANIUM, NIOBIUM, AND TANTALUM: A QUALITATIVE INVESTIGATION. Vogel, D. L.; Rieck, G. D. (Eindhoven Univ. of Tech., Netherlands). Acta Met.; 19: No. 3, 247-54(Mar 1971).

Thermotransport of oxygen and nitrogen in β-titanium, niobium, and tantalum has been studied in a qualitative way using a method previously described. The heat of transport of oxygen and nitrogen in β-titanium is positive. The heat of transport of oxygen, and probably also that of nitrogen, in niobium is very slight. The heat of transport of oxygen in tantalum is negative: a rough estimate has yielded a value of approximately –10 kcal/mole. Strong evidence was obtained that the heat of transport of oxygen and nitrogen in α-titanium is also negative. (auth)

12652 TERTIARY CREEP IN COLD-WORKED ZIRCALOY-2. Coleman, C. E. (Chalk River Nuclear Labs., Ont.). J. Nucl. Mater.; 42: No. 2, 180-90(Feb 1972).

Creep tests have been performed on cold-worked Zircaloy-2 in the temperature range 300 to 450°C at stresses which give rupture within 10^4 hr. In the absence of irradiation the creep was found to accelerate at 0.6 to 4.2% strain. Using specimen profile measurements and numerical calculations based on a homogeneous specimen model, four mechanisms for acceleration have been examined. These are: increase in stress, and therefore strain rate, due to uniform reduction in area; necking; structural changes; and cavitation and fracture. Creep accelerates principally because of the simple stress increase while necking followed by tensile fracture in the neck is the final failure mechanism. Metallography showed that structural changes such as recrystallization do not contribute significantly to the creep acceleration below 350°C. Fast neutron irradiation can reduce the stress sensitivity of the creep rate and this raises the strain for accelerating creep. (auth)

12653 EFFECT OF RHENIUM, NIOBIUM, AND TANTALUM ON THE MECHANICAL PROPERTIES OF DEPOSITED HEAT-STABLE METAL. Sorokin, L. I.; Erokhin, A. A.; Kuznetsov, O. M. Avtomat. Svarka; No. 12, 61-2(Dec 1971). (In Russian).

Welded metal specimens of nickel–chrome alloy with various added amounts of rhenium, niobium, or a tantalum were investigated for their resistance to hot cracking. Changes in the critical deformation velocity as a function of the added metal showed maxima at about 0.9% Re, 4.5% and >11.0% Nb (2 max.), and 0.5% Ta, respectively. (K.S.W.)

12654 THERMAL CONDUCTIVITY OF SOME INDIUM–TIN ALLOYS IN THE SOLID AND LIQUID STATES. Pashaev, B. P.; Revelis, V. G. (Daghestan State Univ., Makhachkala, USSR). High Temp. (USSR) (Engl. Transl.); 9: No. 2, 402-4(Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 440-2(Mar-Apr 1971).

Values for the thermal conductivity of In, Sn, and In–Sn alloys containing 20, 48, 60, and 85% Sn in the solid and liquid states are given. Temperature dependence and phase diagrams of the systems in relation to their thermal conductivity are discussed. Equipment and procedures for the measurements are also given. (T.F.D.)

12655 GROWTH OF GAS BUBBLES IN DEFORMABLE SOLIDS WITH TIME-DEPENDENT HEAT AND MASS SOURCES. Yang, Wen-jei (Univ. of Michigan, Ann Arbor). Jap. J. Appl. Phys.; 11: No. 1, 92-7(Jan 1972).

The equations governing the growth of a spherical inert-gas bubble in a deformable solid resulting from the generation of gas atoms from time-dependent gas sources in the solid matrix are formulated for the general case which includes the effects of surface tension, heat diffusion, and time-varying heat sources in the matrix. The dimensionless parameters controlling bubble dynamics are identified. Asymptotic solutions, valid for large times, are obtained to predict the radius-time relation, the creep rate, and the rates of heat and gas diffusion. Bubble growth in the absence of temperature gradient is also examined. (auth)

12656 DISTRIBUTION OF OXYGEN IN WELDED NIOBIUM. Smiyan, O. D.; Kruzhkov, A. G. Avtomat. Svarka; No. 12, 60 (Dec 1971). (In Russian).

The distribution of oxygen throughout the cross section of welds on niobium metal was investigated. Electron arc welding at 10^{-5} torr, argon-arc welding, and a heliarc technique were studied. The heliarc samples contained a higher O content in the base metal than the vacuum or Ar welds. A difference in homogeneity of O distribution in Nb welds was attributed to a dissimilar heat removal action in He, Ar, and vacuum, respectively. (K.S.W.)

12657 DIFFUSION OF URANIUM IN REFRACTORY BODY-CENTERED-CUBIC METALS. Fedorov, G. B.; Smirnov, E. A.; Zhomov, F. I.; Gusev, V. N.; Paraev, S. A. At. Energ. (USSR); 31: No. 5, 516-18(Nov 1971). (In Russian).

The diffusion coefficients of uranium were measured over the temperature range 900 to 2,200°C for the following metals: Zr, V, Mo, Nb, Ta, and W. The Arrhenius relation (log D vs 1/T) describes the diffusion mobility of U in all body centered cubic metals with the exception of Zr. In a second set of experiments, the activation energies of self-diffusion and diffusion were studied as a function of the melting point of the matrix. The self-diffusion curve obeyed the $E_{act} = 33.4\ T_{mp}$ formula. (K.S.W.)

12658 PREDICTING CREEP IN REFRACTORY METALS. Kovpak, V. I. (Inst. of Strength Problems, Kiev). Strength Mater. (USSR) (Engl. Transl.); 3: No. 4, 429-35(Apr 1971).

Translated from Probl. Prochnosti; No. 4, 56-63(Apr 1971).

A method is proposed for prediction of creep over longer periods for low stress or temperature levels in comparison with test results at higher levels of stress or temperature. The method is based on the hypothesis of the similarity between creep curves with the small difference that similarity in creep curves in a limited range of stress or temperature, based on peculiarities of these values, is assumed. (J.R.D.)

12659 THERMAL EXPANSION COEFFICIENTS FOR SODIUM–POTASSIUM LIQUID ALLOYS. Olson, D. L.; Blough, J. L. (Ohio State Univ., Columbus). Nucl. Technol.; 13: No. 3, 301-8(Mar 1972).

The reported Na–K liquid density data are compared and found to be best represented by the additive expression of the specific volumes. The volume thermal expansion coefficients for these alloys are calculated as a function of temperature and alloy composition. (auth)

12660 PROBABLE DEVELOPMENT OF THE MECHANICAL PROPERTIES OF METALLIC STRUCTURAL MATERIALS STRESSED AT MEDIUM TEMPERATURES. Prohaszka, Janos (Anyagtechnologiai Tanszek, Budapest). Musz. Tud.; 44: No. 3-4, 255-80(1971). (In Polish).

Developments to be expected in the near future toward greater yield point of metallic structural materials are reviewed. The discussion is based on considerations on the increase of the yield point as related to parts of the dislocation theory. By comparing the possibilities for increasing the yield point inherent to the mechanisms for increasing strength, it can be shown that mechanisms most effectively preventing the movement of the dislocations also increase the yield point most effectively. It is concluded

that at medium temperatures at which during tensile testing the influence of the plastic deformation does not decrease, it is martensitic transformation for steels, while for other metals it is segregation hardening from which the greatest increase of strength can be expected. (auth)

12661 SOME PROBLEMS ASSOCIATED WITH STEELS IN HIGH TEMPERATURE SERVICE. Pilkington, R. (Univ. of Manchester, Eng.). Emen; No. 6, 46-54(Nov 1971).

The three major problems associated with steels in high-temperature service are listed, and each is discussed. First, there are those faults that exist in plant after construction, namely fabrication defects, such as heat affected zone (H.A.Z.) cracking around welds. Secondly, there are design faults that result in components being run at higher stresses than calculated, often due to inadequate information about particular stress situations. Finally, there is the long-term metallurgical problem of the drastic loss of ductility that occurs, even in sound material, after slow deformation for long periods at high temperatures. (P.C.H.)

12662 COMPRESSIBILITIES OF LIQUID Sn–Tl, In–Bi, Sn–In, Bi–Sb, AND Bi–Cd–Tl ALLOYS. Berthou, P.-E.; Tougas, R. (Univ. of Montreal). Met. Trans.; 3: No. 1, 51-4(Jan 1972).

The velocity of 5 mHz ultrasonic waves was measured from the liquidus temperature up to a maximum of 500 to 650°C for a certain number of liquid metals and alloys. A semiempirical model of the metallic liquid state was developed to fit the numerical data by varying its six parameters. This model was based on widely admitted assumptions and on an additional hypothesis concerning the excess volume redistribution among the atoms of the liquid. The six calculated parameters were found to have a physical meaning and could be related to the crystalline molar volume at 0°K, to the activation energy for self-diffusion, and to the geometrical characteristics of hard-sphere dense random packings, for the low-melting polyvalent metals and alloys. (auth)

12663 STRUCTURE AN) HIGH TEMPERATURE MECHANICAL BEHAVIOR OF Ni–Ni_3Nb UNIDIRECTIONAL EUTECTIC. Annarumma, P.; Turpin, M. (Ecole des Mines, Paris). Met. Trans.; 3: No. 1, 137-46(Jan 1972).

The structure and mechanical behavior of directionally solidified Ni–Ni_3Nb eutectic have been investigated. The lamellar eutectic grew with the Ni–Ni_3Nb interface semicoherent and, within experimental error, parallel to close-packed planes in both phases. When the temperature was lowered, supersaturation in the nickel-rich phase was relieved mostly by precipitation. Mechanical twinning is the typical deformation mode of the Ni_3Nb phase and was also observed in the nickel phase between 700 and 1000°C. The unusually high ductility of the regular structure below 600°C was related to the high strain hardening rate due to mechanical twinning of the intermetallic and the difficulty of crack propagation. (auth)

12664 INTERACTIONS BETWEEN CREEP, FATIGUE, AND STRAIN-AGING IN TWO REFRACTORY METAL ALLOYS. Sheffler, K. D. (TRW Inc., Cleveland). Met. Trans.; 3: No. 1, 167-77(Jan 1972).

The application of low-amplitude, high-frequency fatigue vibrations during creep testing of two strain-aging refractory alloys (molybdenum-base TZC and tantalum-base T-111) significantly reduced the creep strength of these materials. This strength reduction caused dramatic increases in both the first stage creep strain and the second stage creep rate. The magnitude of the creep rate acceleration varied directly with both frequency and A ratio (ratio of alternating to mean stress), and also varied with temperature, being greatest in the range where the strain-aging phenomenon was most prominent. It was concluded that the creep rate acceleration resulted from a negative strain rate sensitivity which is associated with the strain-aging phenomenon in these materials. (A negative rate sensitivity causes flow stress to decrease with increasing strain rate, instead of increasing as in normal materials.) By combining two analytical expressions which are normally used to describe creep and strain aging behavior, an expression was developed which correctly described the influence of temperature, frequency, and A ratio on the TZC creep rate acceleration. (auth)

12665 HYDROGEN-ENHANCED FATIGUE CRACK GROWTH IN Ti–6Al–4V ELI WELDMENTS. Pittinato, G. F. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). Met. Trans.; 3: No. 1, 235-43(Jan 1972).

The effects of a hydrogen environment on the fatigue crack growth rates in Ti-6Al-4V ELI (STA) and weld material were determined in the temperature range of ambient to –200°F. The hydrogen environment resulted in an acceleration of the crack growth rate and a change in the fracture mode for both materials in the temperature range of ambient to –100°F. At –200°F, there was no significant difference between the crack growth rates obtained in helium and hydrogen gas. The degree of hydrogen-enhanced crack growth was found to be dependent on the crack tip stress-intensity range, temperature, and microstructure of the material. The data is consistent with an embrittlement mechanism involving hydrogen diffusing ahead of the crack front. (auth)

12666 DUCTILE–BRITTLE TRANSITION OF THORIATED CHROMIUM. Wilcox, B. A.; Veigel, N. D.; Clauer, A. H. (Battelle Columbus Labs., Ohio). Met. Trans.; 3: No. 1, 273-83 (Jan 1972).

Unalloyed chromium and chromium containing approximately 3 wt % ThO_2 (2.2 vol %) were prepared from powder produced by a chemical vapor deposition process. When rolled to sheet and tested in tension it was found that the thoriated material had a lower ductile-to-brittle transition temperature (DBTT) than unalloyed chromium. This ductilizing was evident both in the as-rolled condition and after the materials had been annealed for 1 hour at 1200°C. The DBTT values were 140°C for both as-rolled and annealed unalloyed Cr and 15 and 50°C for as-rolled and annealed Cr–3 wt % ThO_2, respectively. The improved ductility in thoriated chromium may be associated with several possible mechanisms such as: particles may disperse slip, such that critical stress or strain concentrations for crack nucleation are more difficult to achieve; particles may act as dislocation sources, thus providing mobile dislocations in this normally source-poor material, in a manner similar to prestraining; and particles in grain boundaries may help to transmit slip across the boundaries, thus relieving stress concentrations and inhibiting crack nucleation. (auth)

12667 ROLE OF PLASTIC ANISOTROPY IN THE FATIGUE BEHAVIOR OF ZIRCALOY. Lee, D. (General Electric Research and Development Center, Schenectady, N. Y.). Met. Trans.; 3: No. 1, 315-22(Jan 1972).

The changes in the plastic properties and the mode of fracture were examined with highly textured Zircaloy-2 under strain-controlled push-pull cyclic loading condition. Since the loading direction was nearly normal to the (0002) poles of hcp structure, deformation occurred predominantly by prism slip. Different twinning systems were also activated when the sign of shear stress changed. The magnitude of plastic anisotropy also changed differently for warm cross-rolled and recrystallized materials. In spite of these structural anomalies, the Coffin-Manson relationship was obeyed, independent of the particular method used for control of diametral strain limits. Depending on the particular orientation of specimen surface, the process of crack initiation could be closely related to the detailed slip morphology. The crack propagation, however, occurred in the direction normal to the surface where the corresponding plastic strain range was the largest. Twinning was also found to contribute importantly to the process of fracture in the cyclic loading condition. (auth)

12668 DISCUSSION OF EFFECT OF MICROSTRUCTURE ON THE STRENGTH, TOUGHNESS, AND STRESS-CORROSION CRACKING SUSCEPTIBILITY OF A METASTABLE β TITANIUM ALLOY (Ti–11.5 Mo–6 Zr–4.5 Sn). Guernsey, J. B.; Petersen, V. C.; Froes, F. H. (Crucible Materials Research Center, Pittsburgh). Met. Trans.; 3: No. 1, 330-41(Jan 1972).

Discussion is presented on the title article, which was previously included in NSA as 25: 13672. The particular points in question include: solution annealing treatment; tensile yield strengths, and stress corrosion susceptibility. An author's reply is included. (P.C.H.)

Structure and Phase Studies

Refer also to abstract 13312.

12669 (BAW–10013) STUDY OF INTERGRANULAR SEPARATIONS IN LOW-ALLOY STEEL HEAT-AFFECTED ZONES UNDER AUSTENITIC STAINLESS STEEL WELD CLADDING. Ayres, P. S.; Barnes, I.; Emmanuel, G. N.; Hoosic, J. F. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation [Dept.]). Dec 1971. 68p. Dep. NTIS.

Intergranular separations have been detected in the heat-affected zone of SA-508, class 2 material melted to coarse-grain practice. This observation was limited to weld cladding deposited by high heat input processes such as strip, two-wire series arc, and six-wire arc cladding. Defects occurred in an area ½ inch wide, defined by the A_3 boundary of the heat-affected zone of the first bead, the A_1 boundary of the heat-affected zone of the second or overlapping bead, and the cladding/base metal interface. The dimensions of these discontinuities have not been observed to exceed 0.156 inch in depth and 0.500 inch in length. It was further noted that the grains of the heat-affected zones of the forgings, where the inter-

granular separations occurred, have coarsened to a much greater degree than the comparable heat-affected zone of plate clad by the six-wire arc cladding procedure. McQuaid-Ehn studies indicated that the austenitic grain size of the forgings ranged from 1 to 4, whereas the grain size in plate material varied from 6 to 8. No intergranular separations have been observed in SA-533, grade B plate materials clad by the six-wire arc process or in single-wire, submerged-arc cladding on either forgings or plates. Metallographic examination of the heat-affected zone in the forging that exhibited the greatest propensity to intergranular separations revealed manganese-sulfide inclusions associated with the defect. This circumstance strongly suggests the existence of liquation as the initiating mechanism. It is believed that the observed intergranular separations are initiated by the liquation of low-melting-point constituents in the grain boundaries of forgings melted to coarse grain practice. Scanning electron microscopy of as-welded versus stress-relieved separations shows one mode of failure in the as-welded material and two modes in the stress-relieved material. Only a smooth fracture mode has been found in the as-welded condition, whereas, after stress-relieving, propagation of the separation occurs as a dimpled rupture type of fracture. A sequence of events that occurs during a high-heat-input cladding operation on SA-508, class 2 material is listed. (P.C.H.)

12670 (IBK–1005) PRECIPITATION IN THE ZIRCONIUM 1,5 WITH TIN BASE ALLOY. Nesic, P.; Stefanovic, V.; Spasic, Z. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). Oct 1970. 5p. INIS.

A second phase precipitation in 1.5 wt % zirconium–tin-base alloy was investigated, using transmission electron microscopy. Homogeneous and heterogeneous nucleation of the second phase resulted in the formation of the tetragonal Zr_4Sn precipitates. Precipitate needles suitable for selected area diffraction analysis enabled the Zr_4Sn/alpha matrix orientation relationship to be determined. Hydride precipitation during foil preparation of some fatigue tested specimens was suspected. (auth)

12671 (SC-RR–710441) STRUCTURE AND MORPHOLOGY OF THIN SPUTTERED NICKEL ALLOY (KOVAR) FILMS AS A FUNCTION OF SUBSTRATE TEMPERATURE. Knudsen, Norman L. (Sandia Labs., Albuquerque, N. Mex.); Stein, Charles (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Aug 1971. 42p. Dep. NTIS.

The crystal structure and morphology of thin sputtered Kovar films as a function of deposition temperature were examined by transmission electron microscopy. The films were deposited on thin substrates of 7052 glass to minimize stresses due to cooling (or heating) from deposition temperature to room temperature. Although the bulk form of this alloy has an Ar_3 temperature between –80 and –100°C, the metastable BCC α phase in the thin films persisted to deposition temperatures up to 500°C. These results were compared with bulk material as well as a film deposited at 18°C which was subsequently heated in the electron microscope. (auth)

12672 COMPARISON OF FINITE-ELEMENT AND EXPERIMENTAL STUDIES ON THE DEFORMATION OF ZIRCONIUM NOTCHED BEND SPECIMENS. Luxmoore, A. R.; Gardner, N. A.; Wyatt, P. J. (Univ. of Wales, Swansea, Eng.). J. Mech. Phys. Solids; 19: No. 6, 395-406(Nov 1971).

In earlier work, A. R. Luxmoore and P. J. Wyatt (1970) described measurements of the deformation of zirconium notched bend specimens, using the Moiré effect. This deformation was simulated by a two-dimensional elastic-plastic finite-element program, and small variations of the crack geometry studied. The numerical and experimental results were compared by studying the crack opening displacement, the crack opening profile, and the size and shape of the plastic zones. (auth)

12673 SHAPE ANALYSIS OF X-RAY DIFFRACTION BROADENING FROM DEFORMED TUNGSTEN. Gupta, Raj K.; Anantharaman, Tanjore R. (Banaras Hindu Univ., India). Z. Metallk.; 62: No. 10, 732-5(Oct 1971).

The shape of x-ray line profiles due to pure diffraction from deformed tungsten as obtained by the Stokes analysis is shown to approximate very closely a Voigt distribution, i.e., a fold of Cauchy and Gaussian distributions. The domain size and strain values are therefore determined conveniently from each x-ray pure-diffraction profile by the Ramarao–Anantharaman single-reflection method. The results from no less than five x-ray reflections demonstrate the internal consistency and reproducibility of this method. The data obtained are compared critically with those obtained by other methods of analysis, including the Pines–Sirenko single-reflection method. (auth)

12674 EFFECT OF CARBON ON STRUCTURE FORMATION IN MOLYBDENUM INGOTS. Ageev, N. V.; Ignatov, D. V.; Kantor, M. M.; Bokareva, N. N.; Makunin, M. S. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk. SSSR; 198: No. 5, 1046-9(11 Jun 1971). (In Russian).

Molybdenum ingots weighing 2.5 kg were prepared in an electric arc furnace and a water-cooled crystallizer for a study of the effects of carbon on Mo structure. Six ingots were prepared with varying carbon contents. The dimensions of the acicular crystals were measured, and their growth tendencies noted with respect to carbon content. Electrolytic etching was used to elucidate the macrostructure. The results showed that the concentration of carbon in the Mo melts significantly influenced the structure formation by affecting the formation of nucleating centers and the crystal growth. (K.S.W.)

12675 UNIDIRECTIONAL SOLIDIFICATION IN SOME ALUMINUM ALLOYS. Forsten, Jarl. Helsinki; Technical University (1969). 94p.

The formation of typical segregation and dislocation structures during the unidirectional solidification of Al and some Al alloys was studied by radiographic methods and measurements of temperature gradients with inserted thermocouples. Microphotometry and optical and transmission electron microscopy were also used. Alloys covered include Al–9.7% Ag, Al–0.9% Au, Al–0.8% Fe, Al–0.06% Ta and Al–0.5% Hf. It was found that longitudinal segregation bands are generated in the solidifying alloy in a pattern depending on the alloying element. A stagnant layer of liquid, through which solute transport occurs only by diffusion, moves in front of the solid/liquid interface. The transversal solute segregation in these alloys never results in a completely hexagonal pattern but instead shows elongated segregation cells. The segregation distance depends on the solidification rate and the alloy element. (Metals Abstr.)

12676 STUDY OF THE DECOMPOSITION OF A SOLID SOLUTION OF TANTALUM IN NICKEL. Zakharova, M. I.; Vasil'eva, N. A. Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 1, 135-6(1971). (In Russian).

The decomposition of a supersaturated α-solid-solution in a Ni–8 at.% Ta alloy was studied by x-ray analysis of single crystals, electron-microscope examination of thin films, and optical microscopy of both single crystals and polycrystalline aggregates, the samples first being annealed at 650 to 800°C. At these temperatures the decomposition of the solid solution took place, without passing through the "zone" stage, by way of the direct separation of three-dimensional Ni_3Ta crystallites. Depending on the precise conditions of the experiments, the crystallite sizes varied from 500 Å to 2 μm. (Metals Abstr.)

12677 INVESTIGATION OF PHASE DIAGRAM IN THE Ta–Co SYSTEM. Pet'kov, V. V.; Kocherzhins'kii, Yu. A.; Markiv, V. Ya. (Kiev State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 9, 852-4(Sep 1971). (In Ukrainian).

By methods of differential, thermal, x-ray, and microstructural analyses the phase diagram of the Ta–Co system up to 50 at. % Ta was investigated. Five stable μ-, λ_1-, λ_2-, λ_3- and X-phases and one metastable phase with the Cu_3Au structure are formed in this system. (auth)

12678 TERNARY SYSTEM YTTRIUM–COBALT–ALUMINUM IN THE RANGE OF 0 TO 33.3 AT. PERCENT OF YTTRIUM. Rykhal, R. M.; Zarechnyuk, O. S. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 9, 854-6(Sep 1971). (In Ukrainian).

By means of the x-ray analysis the ternary system Y–Co–Al was investigated in the range of 0 to 33.3 at. % of yttrium; the isothermal section (at 600°C) was constructed. In the investigated system 4 ternary compounds were found: $YCo_{1\rightarrow1.35}Al_{1\rightarrow0.65}$ (λ_1-phase, the structure of the $MgZn_2$ type: a = 5.39 to 5.36 Å, c = 8.67 to 8.63 Å, c/a = 1.608 to 1.610), $YCoAl_2$ (orthorhombic structure; a = 4.08 Å, b = 10.15 Å, c = 7.06 Å, space group Cmcm, N = 16), ~ $YCoAl_4$ (orthorhombic structure, a = 7.39 Å, b = 12.76 Å, c = 9.39 Å, probable space group $C222_1$, N = 56) and ~YCo_2Al_7 (orthorhombic structure, a = 4.10 Å, b = 16.90 Å, c = 11.95 Å). (auth)

12679 TEMPERING OF THE STRAIN INDUCED MARTENSITIC PHASE IN ZIRCONIUM 3 WT. PERCENT MOLYBDENUM 1 WT. PERCENT ALUMINUM. Northwood, D. O.; Rezek, J.; Turchyn, O. (Univ. of Windsor, Ont.). J. Nucl. Mater.; 42: No. 2, 122-32(Feb 1972).

A study has been made of certain morphological and crystallographic changes associated with the tempering of the strain-induced α_D^1 phase in Zr–3 wt % Mo–1 wt % Al. It has been found that tempering at 500°C of the α_D^1 phase produced a transformation to an $\bar{\alpha}$ phase which was also h.c.p. but which was assumed to contain less molybdenum in solution than α_D^1. Concurrent with the $\bar{\alpha}$ formation, evidence of another phase, probably $ZrMo_2$, which changed from a fine globular coherent precipitate to an incoherent

acicular precipitate as tempering proceeded was found. The c/a ratio for the α_D^1 phase initially increased to a maximum after 8 hr at 500°C and then decreased. This change in c/a ratio seemed to be closely connected with the hardness which followed a similar trend. Tempering at temperatures of 600°C and above produced a partial transformation to the high temperature β-phase. Production of the β-phase caused a reduction in the c/a ratio of the $\bar{\alpha}$ phase as well as considerable softening of the material. (auth)

12680 POLYGONIZATION IN ZIRCONIUM. Mukhopadhyay, P.; Banerjee, S.; Krishnan, R. (Bhabha Atomic Research Center, Trombay, India). Metallography; 4: No. 5, 457-61(Oct 1971).

Discussions are presented on evidences of Zr polygonization based on transmission electron microscopic observations. Thin foils of pure Zr were examined during recrystallization revealing polygonized structures. Micrographs of a number of these structures are included along with explanatory discussions. (J.R.D.)

12681 ELECTRON MICROSCOPE STUDY OF THE LOW TEMPERATURE AGEING BEHAVIOUR OF QUENCHED MOLYBDENUM–NITROGEN ALLOYS. Eyre, B. L.; Evans, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). Acta Met.; 20: No. 2, 267-73(Feb 1972).

It was previously shown that quenching molybdenum at high speeds from elevated temperatures (>1200°C) in a nitrogen atmosphere results in nitrogen being retained in supersaturated solid solution. The present paper reports the results of an electron transmission microscope study of such a supersaturated solid solution isochronally aged to temperatures in the range 200 to 550°C. The experiments have been aimed at supplementing the results of earlier work in which the isochronal recovery of quenched molybdenum nitrogen specimens was followed using resistivity and anelastic measurements. The microscope observations show that after the nitrogen is released from solution, clusters form and grow to a visible size (radius ~15 Å) upon aging to 300°C. The results are related to the physical property measurements and it is concluded that the steady recovery over the temperature range 300 to 450°C is due to a gradual growth of the larger clusters at the expense of the smaller ones. The prominent recovery peak centered at ~500°C is associated with a higher rate of precipitate growth coupled with a change in morphology. (auth)

12682 DISLOCATION ARRANGEMENT AND FLUX PINNING IN DEFORMED NIOBIUM SINGLE CRYSTALS. Schlump, W.; Freyhardt, H.; Nembach, E. (Univ., Goettingen, Ger.). Acta Met.; 20: No. 2, 257-65(Feb 1972).

The interaction between flux lines and dislocations is investigated in twisted niobium single crystals by simultaneously measuring the flux gradient and the dislocation arrangement. With increasing deformation the specimens show tangles of dislocations and the tendency to form a cell structure. Subsequent annealing treatments decrease the dislocation density and lead to a rearrangement of the dislocations into hexagonal networks. This causes a considerable increase of the flux gradient. (auth)

12683 EFFECT OF PLASTIC PRESTRAIN ON MICROSTRAIN BEHAVIOR OF [100] AND [110] TA SINGLE CRYSTALS. Parikh, Prakash D.; Hay, D. Robert (Drexel Univ., Philadelphia). Scr. Met.; 5: No. 12, 1039-43(Dec 1971).

A simple method for obtaining the stress-microstrain behavior of metals is described. The effects of plastic strain on micro- and macro-yielding of Ta are discussed. The results showed a well defined two-stage effect in the microstrain regime. The first stage, region I, was associated with relatively no effects of prestrain on microstructure and a stress polarity effect was evident. The second stage was associated with large scale movement of dislocations on intersecting planes and a pronounced effect on micro- and macrodeformation. Thus, it was concluded that σ_E can only be used as a measure of the relative friction in region I. In region II and beyond, it becomes an orientation dependent function of prestrain, that is of the deformation induced microstructure. (P.C.H.)

12684 EFFECT OF COMPRESSIONAL PLASTIC DEFORMATION ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF INDIUM AND TIN. Swanson, M. L.; Quenneville, A. F. (Chalk River Nuclear Labs., Ont.) Scr. Met.; 5: No. 12, 1081-6 (Dec 1971).

In order to demonstrate which of the defects produced by plastic deformation cause observed changes in transition temperature, T_c, it is necessary to perform annealing experiments after deformation at low temperature. In and Sn were deformed at ~4°K by compression, and ΔT_c and its thermal recovery were measured by the electric conductivity method. The early positive values of ΔT_c were verified, and it was found that point defects are responsible for these changes. (P.C.H.)

12685 LOW-TEMPERATURE LATTICE TRANSFORMATIONS OF HfV_2. Lawson, A. C. (Univ. of California, San Diego, La Jolla); Zachariasen, W. H. Phys. Lett.; 38A: No. 1, 1(3 Jan 1972).

The cubic Laves phase HfV_2 was found to undergo a cubic–orthorhombic transformation below 120°K. (auth)

12686 INFLUENCE OF TEMPERATURE ON SLIP AND TWINNING IN URANIUM. Daniel, J. S.; Lesage, B.; Lacombe, P. (Faculte des Sciences, Orsay, France). Acta Met.; 19: No. 2, 163-73(Feb 1971).

The deformation modes of α-uranium have been studied by performing mechanical tests on single crystals prepared by both the phase shift and the strain-anneal methods. The critical resolved shear stresses for slip on the systems (010)[100], (001)[100], (110)[110], and (021)[1$\bar{1}$2] were determined over a wide range of temperatures. The formation of twins on the systems "{197}" and {130} was facilitated by prior slip and the results indicated a pole mechanism involving $\frac{1}{2}$ [110] slip dislocations for the lateral growth of (130) twins. Lastly, experiments on polycrystalline uranium support the hypothesis that the thermally activated deformation mechanism responsible for the temperature dependence of the flow stress is the overcoming of the resistance of the crystal lattice to the passage of dislocations. (auth)

12687 OBSERVATION OF DISSOCIATED ANTIPHASE BOUNDARIES IN Ni_3Mo. Ruedl, E. (CCR-Euratom, Ispra, Italy); Amelinckx, S. Cryst. Lattice Defects; 2: No. 4, 247-9(Nov 1971).

Dissociated antiphase boundaries, a concept which was recently introduced and illustrated by means of a two-dimensional model, were observed in the ordered alloy Ni_3Mo. Also, doublets as triplets were observed and models are presented. (auth)

12688 FIELD-ION-MICROSCOPE OBSERVATIONS ON PERITECTOID GROWTH OF Ni_4W. Tong, H. C.; Washburn, J. (Univ. of California, Berkeley). Cryst. Lattice Defects; 2: No. 4, 221-38(Nov 1971).

Ni–20 at. % tungsten was successfully imaged and studied by field-ion microscopy. The experiments show that two different mechanisms are involved in the peritectoid reaction, a homogeneous disorder → order transformation, $\alpha \rightarrow \beta$, takes place in the α phase at lower temperatures, but the mechanism is nucleation and growth of β phase involving long-range diffusion of tungsten at higher temperatures. The results suggest that below 800°C, the range of stability of the ordered β phase extends below 37 wt. % tungsten. It was also found that some long-range order with a domain size of approximately 50 ~ 100 Å still existed in the α phase when the alloy was annealed for 9 hours at 1300°C and quenched to room temperature. The defects and substructure resulting from the ordering process are discussed. A correspondent matrix was derived which can be used to determine the conditions under which an antiphase boundary will not be visible on a field ion image. (auth)

12689 YTTRIUM–GERMANIUM SYSTEM. Schmidt, F. A.; McMasters, O. D.; Carlson, O. N. (Ames Lab., Iowa). J. Less-Common Metals; 26: No. 1, 53-70(Jan 1972).

The yttrium–germanium system has been investigated by thermal, microscopic, chemical, and x-ray analyses. Germanium lowered the transformation temperature of yttrium from 1473 to 1460°C by an inverse peritectic reaction. There was a eutectic reaction at 12 at. % germanium and 1280°C between yttrium and the compound Y_5Ge_3, which melted congruently at 1965°C. Another eutectic occurred at 88 at. % germanium and 820°C between germanium and $YGe_{3.5}$, which formed peritectically at 860°C. There were six additional compounds in the system that resulted from peritectic reactions, namely, Y_5Ge_4 at 1945°C; $Y_{11}Ge_{10}$ at 1900°C; YGe at 1730°C; Y_2Ge_3 at 1460°C; $YGe_{1.7}$ at 910°C, and YGe_2 at 880°C. The compound Y_2Ge_3 underwent a polymorphic transformation at 1430°C. New evidence concerning the crystal structures of Y_2Ge_3 and $YGe_{1.7}$ which involve the AlB_2 defect and the $ThSi_2$ defect structure types, respectively, was obtained. The compounds YGe_2 and $YGe_{3.5}$ decomposed eutectoidally at 760°C and 710°C, respectively, and their crystal structures are discussed. (auth)

12690 UNUSUAL MICROSTRUCTURES IN QUENCHED IRON–MOLYBDENUM–COBALT ALLOYS. Domagala, R. F. (Univ. of Illinois, Chicago); Simcoe, C. R. Metallography; 4: No. 6, 569-71(Dec 1971).

Quantitative microprobe analysis was used to confirm the nature of an unusual transformation structure in Fe–5 wt % Mo–5 wt % Co specimens quenched from the $\alpha + \gamma$ field. The type of structure in the specimen quenched from 2200°F can best be described as resulting from a massive transformation of γ at the α/γ interface followed (or accompanied) by a more conventional transformation to martensite within the γ grains. (P.C.H.)

12691 APPLICATION OF FRACTOGRAPHIC TECHNIQUES TO BERYLLIUM. Burns, S. J.; Gurland, J.; Richman, M. H. (Brown Univ., Providence). Metallography; 4: No. 6, 533-50 (Dec 1971).

The metallography of deformed beryllium surfaces revealed considerable plastic flow on the microscale by both slip and twinning. Cracks were arrested or deflected by grain boundaries, and the interaction of twins with grain boundaries seemed to be the main cause of microcrack formation. These microcracks were also associated with inclusions and were both intergranular and transgranular. The latter were directly related to the grain size and expanded in a brittle manner. The fracture surfaces exhibited both ductile and brittle characteristics and both transgranular and intergranular fracture. (auth)

12692 COLOR METALLOGRAPHY FOR TEXTURE ANALYSIS OF TITANIUM. Olsen, R. H.; Smith, W. D. (Boeing Co., Renton, Wash.). Metallography; 4: No. 6, 515-20(Dec 1971).

A color anodizing technique has been developed to study the size, distribution, and morphology of basal-oriented grains in Ti: 6Al–4V. Pole figures, Kossel diffraction, polarized light, and other techniques have been used to confirm that grains anodizing yellow are indeed basal-oriented. In conjunction with pole figures, color anodizing is a very useful means for studying textural variations. (auth)

12693 SOME ELECTRON MICROSCOPE OBSERVATIONS OF THE Co–Co_2Ta EUTECTIC SYSTEM. Desforges, C. D.; Fourdeux, A. (Union Carbide European Research Associates, Brussels). Metallography; 4: No. 6, 487-501(Dec 1971).

The microstructure of the lamellar eutectic β-Co–γ-Co_2Ta, as revealed by thin-film transmission electron microscopy, is described. Lamellar faults were found to be coincidental with subgrain boundaries, and lamellar branching, a probable source of stress concentration in a potential fiber-reinforced material, has been observed. The precipitation of the ordered cubic phase α-Co_3Ta in the β-Co lamellae offers a secondary form of strengthening in eutectic systems. Lateral diffusion of Ta from the β-Co (Ta) solid solution leads to inhomogeneous distributions of the α-Co_3Ta precipitates. (auth)

12694 DIFFRACTION EVIDENCE FOR THE EXISTENCE OF AN fcc ⇌ hcp TRANSFORMATION IN Yb. Kayser, F. X. (Ames Lab., Iowa). Phys. Status Solidi (a); 8: No. 1, 233-41(16 Nov 1971).

X-ray powder patterns obtained from polycrystalline wires of high-purity Yb in several heat-treated conditions have demonstrated the existence of a martensitic transformation, β-Yb (fcc) ⇌ α-Yb (hcp), and that the hexagonal close-packed structure is the thermodynamically stable form for Yb at temperatures below ≈270°K. Precision lattice parameters determined for both polymorphs at room temperature indicate the fractional volume change on the transformation to be 0.0091, a magnitude that is consistent with the belief that α-Yb is divalent. This can be regarded as a stacking fault transformation, and one wherein the preponderance of the volume change is accommodated by displacements normal to the habit plane. (auth)

12695 SOLUTE-SUBGRAIN BOUNDARY INTERACTION IN NIOBIUM. Armstrong, R. W. (Univ. of Maryland, College Park); Raghuram, A. C.; Reed, R. E. Mater. Sci. Eng.; 8: No. 5, 299-300(Nov 1971).

Attempts were made to connect previous results by the authors on solute-subgrain boundary interaction in Nb with those reported by Omar and Entwisle (Mater. Sci. Eng., 5(1969/70)). By virtue of the similar true polycrystal k_y values for the polycrystal grain size results of Omar and Entwisle versus the single crystal subgrain size dependent yield strengths reported by the authors, it appeared that the results and explanation of them were in good agreement with the detailed experiments of Omar and Entwisle. (P.C.H.)

12696 EFFECT OF ALUMINUM ON THE BETA TRANSFORMATION CHARACTERISTICS OF ZIRCONIUM–3 WT. PERCENT MOLYBDENUM. Northwood, D. O.; Rezek, J. (Univ. of Windsor, Ont.). J. Nucl. Mater.; 42: No. 2, 227-31 (Feb 1972).

The effects of aluminum additions on the thermal decomposition of the metastable β-phase in a Zr–3 wt % Mo alloy are reported. X-ray diffraction of a quenched Zr–3 wt % Mo–1 wt % Al alloys indicated that only the β-phase was present. Aging of the quenched alloy at 175°C for 40 hr showed the formation of an ω-phase. After longer aging times, reflections from an α-type were noted. Although the exact percentage of the ω-phase was difficult to determine, there appeared to be less formed in this alloy compared with the Zr–3 wt % Mo alloy. (T.F.D.)

12697 NATURE OF 4f BONDING IN THE LANTHANIDE ELEMENTS AND THEIR COMPOUNDS. Gschneidner, K. A. Jr. (Ames Lab., Iowa). J. Less-Common Metals; 25: No. 4. 405-22(Dec 1971).

A new model is proposed for the electronic configuration of the trivalent lanthanide metals in the condensed state. It is suggested that there are two kinds of 4f electrons—the "atomic" 4f electrons and the 4f "band" electrons. The former are the 4f electrons which are commonly associated with the trivalent metals and ions. The number of 4f atomic electrons varies from zero for La to 14 for Lu and accounts for the normal magnetic susceptibilities observed in the elements and their compounds. The 4f band electron, as the name implies, is one of the valence or conduction band electrons. The 4f band electron occurs because the lowest of the empty energy levels, which vary from 14 for La to one for Tm, lies very close to the Fermi level (and thus is partially occupied by the conduction or valence band electrons) and not well above the Fermi level as has been commonly assumed previously or perhaps completely ignored. The 4f band electron varies from about 0.7 of an electron for the light lanthanides to about 0.1 or less for the heavy lanthanides (for Lu there is no 4f band electron since all 14 atomic 4f levels are filled). The 4f band electron does not contribute to the magnetic susceptibility, except as a conduction electron. It does, however, contribute to the bonding and thus influences the melting point and heat of sublimation. An analysis of these two physical properties permits one to estimate the fractional 4f electron concentration in the valence band. The influence of the bonding 4f electron on ionic and covalent compounds is also briefly discussed. (auth)

12698 PALLADIUM–TUNGSTEN PHASE DIAGRAM BELOW 1100°C. Khan, H. R.; Raub, Ch. J. (Forschunginstitut fuer Edelmetalle und Metallchemie, Schwaebisch-Gmuend, Ger.). J. Less-Common Metals; 25: No. 4, 441-2(Dec 1971).

Results of an investigation of phases of the Pd–W system at temperatures below 1100°C are reported. It is concluded that the phase boundary of the fcc Pd solution exists between 15 and 20 at. % W at 700°C. These data together with earlier results indicate a temperature-dependent solubility of W in Pd–W alloys. (J.R.D.)

12699 YTTERBIUM–CADMIUM SYSTEM. Palenzona, A. (Univ., Genoa, Italy). J. Less-Common Metals; 25: No. 4. 367-72(Dec 1971).

A phase diagram is presented for the ytterbium–cadmium system on the basis of differential thermal, microscopic and x-ray analyses. Six intermetallic compounds were found, all of which are in the cadmium-rich part of the system. Four of these, YbCd, $YbCd_2$, $YbCd_{3.6}$ and $YbCd_{5.7}$, melt congruently at 796, 703, 655 and 636°C, respectively; the other two, Yb_3Cd_8 and $YbCd_6$, form peritectically at 654 and 614°C, respectively. Eutectic points occur at 22.3 at. % Cd and 467°C; 61.2 at. % Cd and 680°C; 75.0 at. % Cd and 648°C; 82.5 at. % Cd and 627°C and at about 99.0 at. % Cd and 317°C. $YbCd_2$ shows a high-temperature modification with a transformation temperature of 695°C. Magnetic susceptibility measurements indicate the divalency of ytterbium over all alloy compositions. (auth)

12700 X-RAY DIFFRACTION STUDY OF DEFORMATION IN H.C.P. RARE-EARTH METALS. Gupta, R. K.; Anantharaman, T. R. (Banaras Hindu Univ., India). J. Less-Common Metals; 25: No. 4, 353-60(Dec 1971).

A detailed analysis has been made of x-ray line broadening in deformed filings of gadolinium, terbium, dysprosium, holmium, and erbium. Values of small domain size, microstrains within these domains and stacking fault probabilities have been arrived at, utilizing Fourier as well as integral breadth analysis. Gadolinium is characterized by a fault probability of ~0.007, but there is no evidence for faulting in other metals. The results of Fourier and integral breadth analysis of several x-ray reflections in each case conform to the elastic isotropy of these rare-earth metals. (auth)

12701 TRANSMISSION ELECTRON MICROSCOPY STUDY OF FACE-CENTERED ORTHORHOMBIC MARTENSITE IN Ti–12.6 PERCENT V ALLOY. Oka, M.; Lee, C. S.; Shimizu, K. (Osaka Univ.). Met. Trans.; 3: No. 1, 37-45(Jan 1972).

The face-centered orthorhombic (fco) martensite newly found in a Ti–12.6 wt % V alloy (11.9 at. % V) has been investigated mainly by means of transmission electron microscopy and diffraction. The axial ratios of the fco martensite were greatly different from those of another orthorhombic martensite (distorted hexagonal) reported by Bagariatskii et al (Soviet Phys. Dokl. English Transl., Vol. 3, p. 1014(1959)). The lattice parameters of the bcc β matrix and the fco martensite were determined by x-ray diffraction to be a = 3.263 Å for the bcc β matrix, and a = 3.561 Å, b = 4.386 Å, c = 4.467 Å for the fco martensite. The orientation relationship between the matrix and martensite lattices was found to be $(0\bar{1}1)_\beta \parallel (001)_{fco}$, $[\bar{1}11]_\beta \parallel [\bar{1}10]_{fco}$ by means

of electron diffraction, and the habit plane was close to $\{133\}_\beta$. $\{111\}$ twins and $\{110\}$, $\{101\}$, and $\{011\}$ planar faults (possibly twins, also) were observed as internal inhomogeneities of the martensite plates. (auth)

12702 INFLUENCE OF COMPETING REACTIONS ON THE EXTENT OF THE β-TO-α MASSIVE TRANSFORMATION IN Ag–Cd, Ag–Zn, AND Cu–Zn ALLOYS. Ayers, J. D.; Massalski, T. B. (Carnegie-Mellon Univ., Pittsburgh). Met. Trans.; 3: No. 1, 261-71(Jan 1972).

The temperature and composition limits of the β-to-α massive transformations, and the influence of the competing reactions, have been studied by means of metallographic and electrical resistivity techniques in the binary systems Ag–Cd, Ag–Zn, and Cu–Zn. Both during quenching, and also under adiabatic conditions achieved by pulse-heating samples that had been quenched previously to retain the β phase, the limits of massive growth of the α phase were found to differ from the equilibrium $\alpha/(\alpha + \beta)$ phase boundary in all three systems. The maximum extent of observable massive growth exceeded this boundary in the Ag–Cd and Cu–Zn systems, but fell well inside the single-phase α field in the Ag–Zn system. In the alloys studied the metastable β phase also transformed by alternative mechanisms, with Widmanstätten α being the major decomposition product at temperatures that were high compared with those at which the massive transformation predominated, and bainite being the major product at lower temperatures. At intermediate temperatures, mixtures of massive α and Widmanstätten α, or of massive α and bainite, were produced. The observed temperature and composition limits of the massive growth are to a great extent determined by the onset of competitive interactions between the different reaction modes. (auth)

12703 ETCH PIT TECHNIQUE FOR TITANIUM AND ZIRCONIUM. Tanabe, T.; Okubo, T.; Gokyu, I. (Tokyo Univ.). Met. Trans.; 3: No. 1, 350-1(Jan 1972).

The determination of crystal orientation in Ti and Zr with a new etch pit technique is reported. Both specimens were electropolished prior to etching in a bath consisting of ethanol (90 cc), butanol (10 cc), anhydrous zinc chloride (28 g), and anhydrous aluminum chloride (6 g). Ti was then immersed for a few seconds into another bath consisting of concentrated HNO_3, HF, and water in the ratio of 5 : 3 : 92. Etch pits were found in matrix and twins. From these the twins were determined to be a $\{11\bar{2}2\}$-type twin, which is expected to be the dominant type when crystals with the c-axis normal to the sheets are cold rolled. In the case of Zr, after the electropolishing step, the specimen was electroetched for 30 sec with a sudden current drop to 0.4 amp. (P.C.H.)

Radiation Effects

Refer also to abstracts 11917, 11988, 13393, 13399, 13400, 13413, and 13414.

12704 (ANL-EBR-44) RESULTS OF IRRADIATION OF NICKEL-REFLECTOR TEST SUBASSEMBLIES. Strain, R. V.; Ruther, W. E. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Aug 1971. Contract W-31-109-eng-38. 40p. Dep. NTIS.

Because of interest in the use of nickel in EBR-II as a reflector material, two subassemblies containing Nickel-200 were irradiated under conditions typical of those for a reflector subassembly. The primary purpose of the irradiation tests was to determine the corrosion rates at sodium flow rates of approximately 0.7 fps and temperatures between 700 and 920°F. Difficulties were encountered during the in-reactor handling of one of the subassemblies, which had been irradiated for one year. The results of the examination showed that Nickel-200 was compatible with the EBR-II primary-system sodium, but that it had swollen at a higher rate than Type 304 stainless steel in the fast neutron flux. The higher swelling rate for the nickel components nearest the center of the reactor core caused the solid Nickel-200 spindle (which held the Nickel-200 test specimens) to bow approximately 0.18 in. at its midlength. The bow of the Nickel-200 spindle in turn caused the subassembly to bow, resulting in the handling difficulties that were encountered. (auth)

12705 DEPLETED ZONE FORMATION AND RECOVERY DURING NEUTRON IRRADIATION. Dollins, C. C. (Bettis Atomic Power Lab., Pittsburgh). Radiat. Eff.; 11: No. 1, 33-8(Oct 1971).

Seeger zones or depleted zones are believed to be responsible for increased hardening in neutron-irradiated materials. An attempt was made to calculate the density of the Seeger zones as a function of temperature, neutron flux, fluence, and dislocation density. The calculations assume an initial zone size at creation and then follow the annealing behavior of the zone. The zone anneals by absorbing vacancies and interstitials and by emitting vacancies. The annealing rates are controlled by the concentration of vacancies and interstitials. These concentrations are in turn dependent upon the Seeger zone density. The point defect concentrations are determined from chemical reaction rate equations. (auth)

12706 STUDY OF CONES DEVELOPED BY ION-BOMBARDMENT OF GOLD. Wilson, I. H.; Kidd, M. W. (Univ. of Sussex, Brighton, Eng.). J. Mater. Sci.; 6: No. 11, 1362-6(Nov 1971).

Argon and xenon bombardment of gold surfaces at 5 to 20 keV resulted in considerable erosion and the formation of cones. A high cone density was found to be characteristic of amorphous (mechanically polished) surfaces while a low cone density with height contrast of the individual grains was discovered on polycrystalline (etched) surfaces. The cone angles were found to vary only slowly with energy, indicating an ion/atom potential that varied much more rapidly with separation than predicted by using a screened coulomb potential. The cones were found to have hexagonal facets and in the case of a polycrystalline specimen, two families of cones were found. These phenomena are attributed to single crystal effects. Similar bombardment of single crystal specimens resulted in a much lower sputtering rate and no cones were generated, probably as a result of channeling of the incident ion beam. (auth)

12707 SIZE, DENSITY, AND DISTRIBUTION OF THE CLUSTERS PRODUCED BY COPPER IONS IN COPPER. Wilson, M. M. (Oxford Univ.). Phil. Mag.; 24: No. 191, 1023-33(Nov 1971).

The precise mechanism by which the damage is produced in copper by energetic particles has not yet been elucidated. In order to throw some light on this problem, the quantity of damage produced by copper ion irradiation of copper was studied in detail by means of transmission electron microscopy. Two irradiation directions were used: one was chosen such that the incident ions were not channeled; the other was ⟨110⟩, a good channeling direction. In the former case, a 30 keV Cu^+ ion produces about one defect cluster larger than 20 Å in diameter, and a 90 keV Cu^+ produces three; the cluster size distributions are identical for the two energies, indicating similar formation mechanisms. In the case of the ⟨110⟩ irradiation direction, channeling reduces the number of 30 Å diameter clusters produced by a Cu^+ ion by a factor of two, and the number of 60 Å diameter clusters by a factor of four. Such behavior is in agreement with theoretical predictions. As would be expected, 30 keV Cu^+ ions incident along a ⟨110⟩ direction produce a damaged layer which extends deeper into the crystal than that produced by Cu^+ ions of the same energy but incident along a non-channeling direction. (auth)

12708 NEUTRON-IRRADIATION-STRENGTHENING IN fcc SINGLE CRYSTALS. Koppenaal, T. J. (Philco-Ford Corp., Newport Beach, Calif.); Arsenault, R. J. Met. Rev. (Publ. in Metals Mater.); 16: No. 157, 175-96(Dec 1971).

The main features of neutron irradiation-strengthening in copper single crystals are considered and it is determined how these observations agree with existing theories. After a brief introductory synopsis of the history of studies in the field, the subject is arranged to cover the principles of irradiation damage, experimental observations of the defects caused by neutron irradiation, basic strengthening features, and the thermal activation analysis of flow stress. It was concluded that there are many areas of disagreement between various investigations, the greatest probably being on whether a single-size obstacle or a spectrum of obstacles exists. (76 references). (UK)

12709 IRRADIATION TEMPERATURE DEPENDENCE OF VOID FORMATION IN TYPE-304 STAINLESS STEEL. Sandusky, D. W. (General Electric Co., Sunnyvale, Calif.); Spalaris, C. N.; Wolff, U. E. Contract AT(04-3)-189. J. Nucl. Mater.; 42: No. 2, 133-41(Feb 1972).

Type-304 stainless steel specimens irradiated in EBR-II were examined by transmission electron microscopy. The neutron fluences ranged from 0.7 to 5.4×10^{22} neutrons/cm^2 ($E > 0.1$ MeV) and the temperatures from 400 to 690°C. Void sizes, size distributions, number densities, and volume fractions were determined and correlated with the irradiation history. Average, minimum, and maximum void diameters increased, and void number density decreased with increasing irradiation temperature to 650°C. Extremely large voids (>2000 Å diameter) were found in specimens irradiated above 500°C. The curve of void volume fraction versus temperature had a plateau that extended from approximately 450 to 600°C and suddenly dropped to zero at about 650°C; above that temperature no voids were found. The results are discussed in terms of void nucleation and growth. (auth)

12710 EFFECT OF INTERSTITIAL IMPURITIES ON THE ANNEALING OF NEUTRON-IRRADIATED VANADIUM. Stanley,

J. T.; Williams, J. M.; Brundage, W. E.; Wechsler, M. S. (Oak Ridge National Lab., Tenn.). Acta Met.; 20: No. 2, 191-8(Feb 1972).

Annealing of neutron-irradiated vanadium was investigated in the temperature range 100 to 300°C using internal friction and resistivity measurements. The results indicate that the resistivity annealing stage at about 185°C is due to the migration of interstitial oxygen and carbon to radiation-produced defects, possibly small dislocation loops. This conclusion is based on evidence that the magnitude of the resistivity annealing stage was larger for vanadium with higher oxygen and carbon contents. Also, the Snoek internal friction peak due to oxygen and carbon decreased upon post-irradiation annealing at 185°C by an amount consistent with the observed resistivity decrease, and the resistivity decreased during post-irradiation annealing to below the pre-irradiation value. The activation energy for the resistivity annealing, 1.2 ± 0.1 eV, is the same as the activation energies for oxygen and carbon migration, 1.26 and 1.18 eV, respectively. (auth)

12711 NUCLEATION OF DISLOCATION LOOPS IN SOLIDS UNDER IRRADIATION. Loh, B. T. M. (Oak Ridge National Lab., Tenn.). Scr. Met.; 5: No. 12, 1049-51(Dec 1971).

In studying the formation of voids in solids during neutron irradiation, it has become clear that classical nucleation theory is not applicable because of the coexistence of excess vacancies and interstitials. The same approach as that for the effects of excess interstitials in void formation should also be applicable to the nucleation of dislocation loops during irradiation. The solution for loop nucleation is a matter of exchanging some parameters described previously by Katz and Wiedersich (J. Chem. Phys. 55, 1414 (1971)). The exchanges needed to convert the void nucleation model to an interstitial loop nucleation model are given. (P.C.H.)

12712 RADIATION EFFECTS ON THE PEAK OF GRAIN BOUNDARIES IN Al AND IN AN Al–Li ALLOY. Woirgard, J. (Ecole Nationale Superieure de Mecanique et d'Aerotechnique, Poitiers, France); Gacougnolle, J. L.; Sarrazin, S.; (and others). J. Phys. (Paris), Colloq.; 71: No. 2, 87-92(1971). (In French).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

Radiation effects on grain boundary relaxation in Al and in Al–Li alloys were investigated by internal friction. The specimens, in the form of flat bars, were submitted to a torsion, at low frequencies and amplitudes. The existence of a gaussian relaxation spectrum was assumed and the formalism of Nowick and Berry was used. It was found that the entropy factor, the activation energy, and the relaxation strength decrease when the radiation doses increase. The results may be explained in terms of the model proposed by Roberts and Barraud for grain boundary damping in cfc metals. In this model, the relaxation is assumed to be due to the migration of grain boundary dislocations. The decrease in the entropy factor may be attributed to the pinning of dislocations in some boundaries after segregation of the defects due to irradiation. The relaxation length decreases with the dislocation migration distance. The defects slow down vacancies and thus the activation energy decreases. Radiation effects on Cu were shown to be more important. (France)

12713 DISLOCATION PINNING RATE IN X-RAY IRRADIATED COPPER BETWEEN 78 AND 240 DEG K. Roth, G.; Sokolowski, G.; Luecke, K. (Technische Hochschule, Aachen). J. Phys. (Paris), Colloq.; 71: No. 2, 145-6(1971).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

The pinning rate of dislocations in Cu was determined by measuring the integral friction and the torsion modulus during an isothermal irradiation with x-rays in a temperature range between 78 and 210°K. The results obtained from damping measurements are in agreement with the existence of a minimum in the pinning rate at 160°K as reported by Thompson and Buck. However, this minimum was not obtained from the measured values of the modulus and a dependence of the apparent pinning upon the temperature of measurement was observed so that it seems doubtful that the minimum is a true effect of the pinning rate. (France)

12714 INTERNAL FRICTION AND MODULUS MEASUREMENTS IN COLD-WORKED AND ELECTRON-IRRADIATED COPPER AT LOW FREQUENCIES. Brumme, H.; Ebener, H.; Sokolowski, G. (Technische Hochschule, Aachen). J. Phys. (Paris), Colloq.; 71: No. 2, 147(1971).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

The effect of cold-working and of 3-MeV electron irradiation on the internal friction and the shear modulus of polycrystalline Cu was measured at 1 Hz. The decrement is given as a function of the temperature for the undeformed sample, the sample after 7% cold-work at 78°K, and the annealed sample. The main structure of the curve after deformation is the peak P_2 at about 160°K. The peak temperature is shifted to lower values by increasing plastic deformation and can be related to the dislocation density of the samples. For temperatures above 200°K there is no pronounced structure. The decrement is given for a sample irradiated with 3-MeV electrons at 100°K up to a defect concentration of $3\ 10^{-7}$. Between 120 and 330°K the difference between the irradiated and the unirradiated sample gives a very broad peak. The fact that irradiation increases the internal friction does not fit the commonly accepted views on dislocation damping. It must be assumed that the point defects themselves or their interaction with dislocations produce this very broad peak. (France)

12715 TEMPERATURE DEPENDENCE OF PINNING BY IRRADIATION-INDUCED POINT DEFECTS IN COPPER. Winterhager, P.; Roth, G.; John, R.; Luecke, K. (Technische Hochschule, Aachen). J. Phys. (Paris), Colloq.; 71: No. 2, 151-2(1971).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

Cu dislocations were pinned by low temperature irradiation or by heating low temperature irradiated samples up to sufficiently high temperatures. Kilocycle and megacycle damping measurements show that subsequent temperature changes do not alter the number of pinning points. The result is not consistent with the model of Thomson et al., in which a thermal equilibrium is assumed between the point defects acting as pinning points and the point defects located at dislocation nodes. (France)

12716 HASIGUTI PEAKS AND MODULUS ANOMALY IN PURE COLD-WORKED Au IRRADIATED AT 78 DEG K. Bays, B.; Benoit, W.; Grandchamp, P. A. (Ecole Polytechnique, Lausanne, Switzerland). J. Phys. (Paris), Colloq.; 71: No. 2, 153-7 (1971). (In French).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

Internal friction and modulus defect measurements showed that the peak P_2 observed in gold after cold working at 78°K is due to the simultaneous presence of point defects and dislocations in the crystal. Samples irradiated at 78°K show a peak P_2 only if they contain sufficient amounts of dislocations. The latter are created by torsion cold working at 300°K, followed by annealing during which the point defects disappear. A study of P_2 observed after irradiation, and in connection with the annealing temperature shows that the peak only appears on cold-worked samples annealed at about 570°K. The results are compared with background internal friction measurements carried out on cold-worked samples annealed at various temperatures between 370 and 670°K. (France)

12717 DISLOCATION PINNING AND DEPINNING IN ELECTRON IRRADIATED MOLYBDENUM. Lomer, J. N.; Richardson, J. F. R. (Univ. of Reading, Eng.). J. Phys. (Paris), Colloq.; 71: No. 2, 169-72(1971).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

Previous work on polycrystalline electron irradiated molybdenum showed that dislocation pinning occurred between 40 and 70°K. This is the region of the resistivity annealing stage I_4 and is interpreted as arising from the migration of interstitials to the dislocations. Measurements have now been extended to 830°K. One further pinning stage occurred at 520°K. This can be correlated with the resistivity annealing stage III and is thought to arise from the migration of a vacancy type defect. A broad region of depinning occurred between 90 and 290°K in polycrystalline samples, and at somewhat lower temperatures in single crystals. The depinning is thought to arise from the release of interstitials from dislocations of different character. This means that the structure of the dislocation network must be different in single and polycrystals. Partial depinning occurred between 550 and 650°K in all the samples. It is thought to arise from clustering of the vacancy type defects on the dislocation lines. (France)

12718 MEASUREMENT OF THE INTERNAL FRICTION OF COLD-WORKED Au AFTER NEUTRON IRRADIATION IN THE KILCHERTZ RANGE. Grandchamp, P. A. (Ecole Polytechnique, Lausanne, Switzerland). J. Phys. (Paris), Colloq.; 71: No. 2, 229-41(1971). (In French).

From Conference on anelastic effects due to defects and phase transformations in solids; Lausanne, Switzerland (24 Jun 1970).

The properties of the Bordoni peak were studied in 99.999% pure Au. The effects of the type and rate of the cold-working process used on the relaxation strength, relaxation characteristics, and effect of the pinning of dislocations on the Bordoni peak were examined. The height of the Bordoni peak obtained by strain-

hardening is roughly proportional to the rate of plastic deformation. The relaxation energies and the stress frequencies corresponding to the Bordoni peak were determined for polycrystals and single crystals. The peak broadening was experimentally studied. The peak height was obtained in terms of the dislocation density and of the mean length of the dislocation loops involved in the phenomenon. (France)

12719 RATING THE LONG-TERM STRENGTH OF CONSTRUCTIONAL MATERIALS INSIDE A REACTOR. Votinov, S. N.; Losev, N. P.; Prokhorov, V. I.; (and others) (Volgograd Polytechnic Inst., Melekess, USSR). Strength Mater. (USSR) (Engl. Transl.); 3: No. 5, 558-61(May 1971).

Translated from Probl. Prochnosti; No. 5, 61-4(May 1971).

Testing at 200 hr in the channel of an SM-2 reactor with a flux of $2.5 \cdot 10^{12}$ cm$^{-2} \cdot$ sec^{-1} fast neutrons and $6 \cdot 10^{13}$ cm$^{-2} \cdot$ sec^{-1} thermal showed that the time until failure of tubes of 0Kh16N15M3B, 0Kh16N15M3BR, and Kh18N10T steels at 650°C under radiation dropped in comparison with the time until failure without radiation by not more than three to ten times. The deformation at failure of the tubular steel samples tested in the reactor was about one-and-a-half times less than that of those outside the reactor. (auth)

12720 LENGTH CHANGES IN β-PLUTONIUM DUE TO SELF-IRRADIATION DAMAGE AT 4K. Marples, J. A. C.; Hall, R. O. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 42: No. 2, 212-16(Feb 1972).

A sample of β-plutonium, stabilized by quenching, has been held for over 3000 hr in liquid helium. The resulting contraction fit closely to an exponential equation of the usual form: $\Delta l/l = 4.90 \times 10^{-3} (1 - \exp(-2.35 \times 10^{-4}t))$. It is suggested that the contraction is due to the formation under irradiation of an amorphous form of plutonium. (auth)

12721 EFFECT OF NEUTRON IRRADIATION AND EXTENSION RATE ON THE ELEVATED TEMPERATURE MECHANICAL PROPERTIES OF Ni AND Ni-BASED ALLOYS. El-Shanshoury, I. A.; Gadallah, F. I.; Hammad, A. M. (Atomic Energy Establishment, Cairo). J. Nucl. Mater.; 42: No. 2, 203-11(Feb 1972).

The effects of neutron irradiation (2×10^{18} to $8 \times 10^{15} n_f/cm^2$ and 5.5×10^{18} to $2.2 \times 10^{16} n_{th}/cm^2$), extension rate (0.11 to 80 mm/min) and grain size on the elevated-temperature (400 to 900°C) tensile properties of Ni, 80 Ni–20 Cr, 60 Ni–20 Cr–20 Fe, and 40 Ni–17 Cr–43 Fe and nimonic alloys were studied. It was found that low extension rates, coarse grains, and increase in neutron dose decrease the ultimate tensile strength (UTS) and elongation of the investigated materials. The loss in strength and ductility of the irradiated and unirradiated materials was attributed to the intergranular fracture of the specimens. It was found that recrystallization of cold-worked and irradiated specimens increased their ductility over the annealed and irradiated ones. The UTS and elongation of unirradiated specimens were found to be linearly dependent on the logarithm of extension rate, while the slopes of the strength-log. rate relations were found to decrease linearly with T^{-1}. The embrittlement of irradiated nimonic alloy was found to be due to the formation of the compound Ni_3Al. Neutron irradiation did not affect the precipitation process and its only effect was the increase of the structure-sensitive term, A, of the Arrhenius equation $R = A \exp(-46{,}000/RT)$. Formation of helium bubbles was considered to be an additional source for the nucleation of cracks. (auth)

12722 GRAPHITE MATERIALS DATA FOR HIGH-TEMPERATURE NUCLEAR REACTORS. Everett, M. R.; Blackstone, R.; Graham, L. W.; Manzel, R. (OECD Reactor Project, Winfrith, Eng.). pp 373-82 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

The design of a high-temperature helium-cooled nuclear reactor involves extensive irradiation property change data for graphite materials used in the core. A survey is given of the present data position on the dimensional and physical property changes, on irradiation at temperatures of 600 to 1200°C to neutron doses of ~4×10^{21} n/cm^2 Ni-dose Dido equivalent, of pyrolytic carbon used for coated particle fuels, fuel compacts made by pressing coated particles in a resin bonded graphite powder matrix, and nuclear grade graphites suitable for fuel tubes and moderator blocks. Some aspects of the thermal performance and stress problems in fuel elements are discussed where these are significantly influenced by graphite materials selection and design. (auth)

Ceramics and Cermets

Refer also to abstracts 11936, 12579, and 12580.

Corrosion and Erosion

Refer also to abstract 12591.

12723 (AECL–4063) INTERNAL SOURCES OF HYDROGEN IN UNIRRADIATED UO_2 FUEL ELEMENTS. Denovan, A. S.; Ashley, R. W.; Longhurst, T. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Oct 1971. 23p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

An investigation has been carried out to determine the source of hydrogen causing localized hydriding in the zirconium alloy sheathing of fuel elements. The sources examined were hydrocarbons, molecular hydrogen, water in fuel elements, and internal contamination of sheathing. Both the fuel element filling gas and gases adsorbed by the UO_2 fuel pellets were analyzed. Studies were also carried out to determine the extent of pickup of hydrogen during the sintering process and of water from the atmosphere by fuel pellets. The conclusions reached were that the major contributor to hydrogen in fuel elements was water adsorbed on the surface of fuel pellets. (auth)

12724 CORROSION STABILITY OF DIBORIDES OF CHROMIUM, TANTALUM, AND THEIR ALLOYS IN HIGH-PRESSURE WATER. Arabei, B. G.; Myshkin, V. A.; Tikhonova, R. S.; Frolova, K. I. Prot. Metals (USSR) (Engl. Transl.); 7: No. 1, 10-12(Jan-Feb 1971).

Translated from Zashch. Metal.; 7: No. 1, 16-19(Jan-Feb 1971).

The corrosion stability of diborides of tantalum, chromium, and their alloys in water was investigated at temperatures from 150 to 350°C and pressures correspondingly from 4.85 to 168.8 atm. A qualitative and quantitative evaluation of the corrosion stability is given. The influence of the porosity and temperature of testing on the stability of the materials in high-pressure water was demonstrated. (auth)

12725 INTERACTION OF CURIUM SESQUIOXIDE WITH REFRACTORY METAL MATRICES IN PRESSED AND SINTERED CERMET COMPACTS. Donovan, J. A.; Rankin, D. T.; Stuckey, J. E.; Smith, P. K.; McDonell, W. R. (Savannah River Lab., Aiken, S. C.). Nucl. Technol.; 13: No. 3, 273-83(Mar 1972).

No reaction was observed between B-type $^{244}Cm_2O_3$ and tungsten, molybdenum, or rhenium matrices in cermet compacts fabricated by cold pressing and sintering at temperatures up to 1850°C. Reaction was observed, however, between the oxide and tantalum matrices sintered as low as 1400°C. Cold pressing and sintering at the highest temperatures produced generally well-consolidated Cm_2O_3-refractory metal compacts of 85% or greater theoretical density. In compacts produced from well-mixed powders, the oxide was distributed uniformly in the metal matrix with little vaporization loss of Cm_2O_3. (auth)

12726 THIRD CONFERENCE ON INDUSTRIAL CARBONS AND GRAPHITE. Conference Held at London, April 14–17, 1970. London; Society of Chemical Industry(1971). 565p. Pound 15.00. (CONF-700407). (In English and French)

Ninety papers were presented under the session headings: crystal structure, texture and physical properties; graphite intercalation compounds; carbon formation and graphitisation; adsorptive properties and pore structure; oxidation of carbons and graphite (including radiolytic oxidation); nuclear graphite; carbon fibres; and carbon as a material in mechanical, electrical and chemical engineering. Discussions are included. Separate abstracts have been prepared for 22 of the papers. (UK)

For abstracts of individual papers see: 11814–11817, 12722, 12727–12730, 12740, 12767–12772, 12794, 12795, 12802–12804, and 13456.

12727 THERMAL OXIDATION OF NUCLEAR GRAPHITES IN THE RANGE 650 TO 750°C. Board, J. A.; Billinghurst, A. (Atomic Power Constructions Ltd., Heston, Eng.). pp 271-6 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

A wide range of nuclear graphites was exposed to pure CO_2 and reactor atmospheres at 400 lb/in^2 (gage) and up to 750°C for periods up to 6000 hr. A ^{14}C tracer technique was also used. CO is an oxidation inhibitor at lower temperatures but becomes ineffective at higher temperatures. CH_4 added to CO_2–CO mixtures further inhibits oxidation. In an AGR gas mixture PGA graphite would oxidize at a rate of 1%/year at 720°C. Isotropic graphites from different manufacturers varied widely in reactivity. (auth)

12728 SOME EFFECTS OF OXIDATION ON THE PROPERTIES OF GRAPHITE. Knibbs, R. H.; Morris, J. B. (Atomic Energy Research Establishment, Harwell, Eng.). pp 297-308 of

Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

The effects of thermal oxidation by air on the properties of Pile Grade A graphite (PGA) were studied, using about 400 samples. This type of corrosion had a more severe effect on strength and electrical resistivity than had thermal carbon dioxide or radiolytic carbon dioxide oxidation. Strength and resistivity both changed by a factor of two after weight losses of only 5 and 10%, respectively. It appeared that the attack was very selective, the graphite cohesion being completely destroyed after about 30% weight loss. An additional loss by erosion in the air flow over the surface became progressively more important as oxidation proceeded. Although the block of graphite used was of normal production quality, it was exceptional in that its reactivity was about five times greater than usual, and it showed no real anisotropy in strength. During oxidation the relative changes in resistivity varied with the direction of cut, but no such variation was observed in strength. The rate of oxidation was constant throughout the experiment in spite of a 6-fold increase in accessible surface area. The variability of properties measured on samples of 11 cm^3 bulk volume increased in the order density, resistivity, oxidation rate, and strength. (auth)

12729 TRANSIENT HEAT AND MASS TRANSFER EFFECTS IN THE OXIDATION OF TUBULAR SPECIMENS OF GRAPHITE IN AIR. Klaschka, J. T.; Lewis, J. B.; Murdoch, R.; Stevens, J. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 316-21 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

The initial unsteady state oxidation rates observed when a large specimen of graphite, preheated in nitrogen, was suddenly exposed to air were studied. Temperatures in the region of 500 to 550°C were used. The overall reaction rate was found to be controlled by in-pore mass transport of oxygen. A mathematical model was developed which satisfactorily describes the observed results. From these values of the reaction rates, activation energies and diffusion coefficients were calculated, which were in good agreement with values previously obtained under steady-state conditions. (auth)

12730 OXIDATION OF ^{14}C-LABELLED PILE GRADE A GRAPHITE. Dominey, D. A.; Sharpe, B. P. K. (Atomic Energy Research Establishment, Harwell, Eng.). pp 322-8 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

Five specimens of Pile Grade A graphite labeled with ^{14}C by exchange of carbon atoms with ^{14}CO at 2400°C were oxidized by a variety of methods and the specific activities of the products were compared. For three specimens, which had all been heated to at least 2700°C after labeling, the specific activity of the gasified carbon was largely independent of the method of oxidation and of burn-off. However, the specific activity of carbon gasified from the two specimens, which had not been heated to 2700°C after labeling, decreased with increasing burn-off and varied with the method of oxidation. An attempt is made to explain the observed differences in terms of current ideas on the mechanism of oxidation of graphite. (auth)

Preparation and Fabrication

Refer also to abstract 11891.

12731 METHOD OF UNITING GRAPHITE ARTICLES. Anikin, Leonic Trifonovich; Kravetskii, Gennady Alexandrovich; Dergunova, Viktoria Sergeevna; Dutov, Valeri Vasilievich. British Patent 1,255,913. 1 Dec 1971. Filed 20 Jan 1970.

A method is described for joining graphite bodies by placing a layer of metal between the bodies to be joined and heating above the temperature of formation of a carbide of the metal and to or above the temperature at which a eutectic mixture of carbon and carbide forms, the joint thus comprising a eutectic mixture. Since the latter comprises a considerable proportion of C the thermal resistance of the joint approaches that of graphite. In order to obtain a high quality joint, the area around the joint should be heated 20 to 50°C above the initial temperature at which the eutectic commences to form. (UK)

12732 METHOD OF MAKING NUCLEAR FUEL ELEMENTS. Drittler, Karl; Luhleich, Hartmut (to Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH). U. S. Patent 3,620,835. 16 Nov 1971. Filed 14 Jun 1968.

Description is given of the development and fabrication of a nuclear fuel element in the shape of a wire or rod which includes: a rodlike or wirelike inner carrier element of high melting temperature metal selected from the group consisting of molybdenum, tungsten, tantalum, and chromium, a layer of material selected from nuclear fuel and nuclear breeder material arranged around and supported on said carrier element and being heat resistant up to a temperature above 2,000°C, and an outer envelope surrounding said layer and selected from pyrolytic graphite and ceramics for preventing the fission products from penetrating to the outside of the fuel element. (Official Gazette)

12733 METHOD OF PRODUCING COATED PARTICLES. Koss, Peter; Markl, Heinz; Kofler, Otmar; (and others) (to Oesterreichische Studiengesellschaft fuer Atomenergie GmbH). British Patent 1,249,336. 13 Oct 1971. Priority date 7 Dec 1967, Austria.

A method of producing coated actinide particles for use at high temperatures in reactors is described. Compounds of Th, Pu, or U are sprayed in suspension in a polymerizable organic compound to form particles on which the polymer is carbonized under conditions conducive to oxidation of the actinides. Argon is used as the initial fluidization gas for high-temperature reactions while CO is used at lower temperatures. (J.R.D.)

12734 PROCESS FOR PRODUCING DENSE PARTICLES OF PLUTONIUM COMPOUNDS USABLE AS FUELS FOR NUCLEAR REACTORS. (to Comitato Nazionale per l'Energie Nucleare). British Patent 1,252,272. 3 Nov 1971. Priority date 13 Oct 1967, Italy.

A process is described for producing dense particles of plutonium compounds or mixed compounds consisting of beryllium, zirconium, and metals in the actinide and rare earth series. The particles produced by this process are suitable for use as fuels. The process is simple, inexpensive, and can be applied in automatized and remotely operated plants. (J.R.D.)

12735 TRANSPARENT THORIA-BASE CERAMICS AND METHOD FOR PRODUCING SAME. Jorgensen, Paul J. (to General Electric Co.). U. S. Patent 3,615,756. 26 Oct 1971. Filed 3 Jul 1967.

The preparation of high-density thoria-base ceramic bodies containing up to 8 mole % of CaO is disclosed. These bodies have high orders of in-line transmission of light between about 0.3 and 10.0 microns and are prepared by pressing the mixed powders and sintering in a hydrogen water vapor atmosphere until theoretical density is achieved. (Official Gazette)

12736 PROCESS FOR THE PRODUCTION OF A COMPOSITE MATERIAL Al–Mg–Al_2O_3–MgO. Gualandi, Dante; Jehenson, Pierre (to EURATOM). U. S. Patent 3,619,894. 16 Nov 1971. Priority date 31 Aug 1967, Italy.

A method is described for producing sintered composite Al–Mg–Al_2O_3–MgO material for nuclear applications, comprising grinding an Al–Mg alloy powder in air using an aluminum mill and a grinding lubricant, cold compressing the ground powder, effecting a controlled oxidation to form a double oxide Al_2O_3–MgO product; sintering and degasifying the product, hot compressing and then extruding the product. (Official Gazette)

12737 REDUCTION/SINTERING OF ADU. Haroun, N. A. Aly, M. M. (Atomic Energy Commission, Cairo). J. Nucl. Mater.; 42: No. 2, 232(Feb 1972).

A preliminary investigation of a process for the reduction/sintering of ammonium diuranate (ADU) pellets into uranium dioxide pellets is described. The process is aimed at eliminating the UO_2 powder preparation step. Pellets of UO_2 were prepared by compressing ADU powders at 10,000 to 70,000 psi and heating in hydrogen at variable rates to the sintering temperature of 1540°C. All prepared UO_2 pellets were either cracked or broken except those compacted at 10,000 psi and receiving a low heating rate. The low heating rate allowed the gases formed during the reduction stage to escape before sintering occurred. (T.F.D.)

12738 CONVERSION OF MULTI-GRAM QUANTITIES OF $^{241}AmO_2$ TO $^{241}AmF_4$. Conner, W. V. (Dow Chemical Co., Golden, Colo.). J. Less-Common Metals; 25: No. 4, 379-84 (Dec 1971).

A process has been developed for the rapid and complete conversion of $^{241}AmO_2$ to $^{241}AmF_4$, using fluorine gas. The conversion was studied at starting temperatures varying from room temperature (30°C) to 300°C and with AmO_2 batch sizes ranging from 6 to 30 g. A fluorine flowrate of 200 to 400 cm^3/min was used for all of the runs. The conversion process was monitored by measuring the neutron emission rate from the alpha-neutron

reaction associated with AmF_4. Conversion efficiencies of 100% were obtained over the entire range of starting temperatures and batch sizes used. Fluorination periods of 20 to 35 min were found to be sufficient for complete conversion of AmO_2 to AmF_4. (auth)

12739 SINTERING OF UO_2: A STUDY OF THE DEVELOPMENT OF HIGH DENSITY AND CONTROLLED MICROSTRUCTURE IN THE SINTERED URANIA PELLETS. Moorthy, V. K.; Anandan, N. S. (BARC, Bombay). Trans. Indian Ceram. Soc.; 27: No. 5, 145-58(1968).

Studies were made on the relations between powder properties, sintering treatments, and densification and microstructure development in urania pellets. Urania powders were prepared from ammonium diuranate by decomposition and reduction at various temperatures, namely, 400, 600, 900, 1200, and 1500°C. Pellets prepared from these powders were sintered from 1200 to 1700°C with different soaking periods. The influence of sintering temperature, soaking periods at different temperatures, intermediate soaks at varying time periods at various temperatures, reheating of prepared sintered pellets, and rates of heating during sintering on the density and microstructure development of pellets was studied. The study revealed that urania pellets of specified density and grain development can be prepared by first attempting to achieve densification and then continuing the thermal treatments to attain the desired grain size and microstructure. (Indian Sci. Abstr.)

12740 PREPARATION AND PROPERTIES OF SILICON-CONTAINING PYROLYTIC CARBONS. Marinkovic, S.; Suznjevic, C.; Dezarov, I.; (and others) (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 102-8 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

A study of simultaneous chemical vapor deposition of carbon and silicon from a CH_4-SiCl_4 gas mixture at deposition temperatures 1100 to 1630°C, total gas pressures 50 to 200 mm Hg, CH_4 flow rate 2000 ml/hr and 2 to 75% $SiCl_4$ in the gas mixture, gave the following conclusions: There is a pronounced effect of the presence of $SiCl_4$ in the gas phase on the deposition rate, which is increased at low temperatures by a factor of 4 to 5. The product of codeposition is essentially pyrocarbon. Its maximum Si content amounts to 13% at low deposition temperatures (1350°C) and decreases to 0.3% at 1630°. The lowest temperature at which the $SiCl_4$ can be decomposed is about 1150°C, where 4 to 5% Si is retained in the deposit. A small quantity of Si (0.15 to 0.20%) probably enters the pyrocarbon lattice by substitution, considerably improving the structural properties (three-dimensional ordering, crystallite size, preferred orientation, density). Graphitized carbon crystals appear at this concentration. It seems possible that the presence of Si prevents formation of amorphous carbon, which probably exists in some quantity in the pure pyrocarbon. Si content in excess of 0.2% is present as a separate phase, β-SiC. Products with higher Si content (≥1.5%) are characterized, except at lowest deposition temperatures, by heterogeneous microstructure and Si distribution. In addition to the narrow-cone structure representing the solid solution with 0.2% Si, the deposits contain large cones with an increased Si content. These cones grow from small essentially pure β-SiC inclusions, which are possibly formed by carburisation of pure Si droplets. Heat treatment (3 hr at 2000°C) leads to a substantial change of structural properties of Si-rich deposits, but without noticeable change in Si distribution. (auth)

Properties Evaluations

Refer also to abstracts 11669, 11983, 12640, 12647, 13432, 13436, 13440, 13444, and 13456.

12741 (GEAP-13732) COMPRESSIVE CREEP OF URANIA-PLUTONIA FUELS. Evans, S. K.; Bohaboy, P. E.; Laskiewicz, R. A. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Aug 1971. Contract AT(04-3)-189. 36p. Dep. NTIS.

Measurements of steady-state creep have been carried out on the urania-plutonia system using a compression technique. The results support (but do not establish) hypotheses regarding mechanisms of creep to the effect that at low stress (less than 3000 psi), creep is controlled by grain boundary diffusion (an inverse cube dependence on grain size is observed) and at higher stress (greater than 6000 psi), creep is controlled by dislocation motion. The most sensitive parameter for fast reactor fuel is stoichiometry; increasing O/M from 1.95 to 2.00 increases the strain rate by a factor of 8 (for $UO_2-20\%$ PuO_2). Strain rate also increases with plutonium content, porosity, and temperature. An empirical equation has been developed which relates strain rate with all of these parameters. Activation energies for the creep of $UO_2-20\%$ PuO_2 at −100 and −140 kcal/mole observed here are similar to those reported for UO_2. (auth)

12742 ANISOTROPIC THERMAL EXPANSION OF URANIUM-REFRACTORY METAL-CARBIDES: UWC_2 AND $UMoC_2$. Uchida, Masaaki; Ichikawa, Michio (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 11, 651-3(Nov 1971).

Thermal expansion measurements were made on UWC_2 and $UMoC_2$ by high temperature x-ray diffraction in the range from room temperature to 1100°C. The results showed that the two compounds were nearly alike in the temperature range used, with $UMoC_2$ showing a slightly greater expansion. (P.C.H.)

12743 THEORY OF BASAL PLANE THERMAL CONDUCTIVITY OF GRAPHITE. Logatchov, Yu. A.; Skal, A. S. (Inst. of Semiconductors, Leningrad). Carbon; 9: No. 6, 711-14(Dec 1971).

A calculation of the basal plane thermal conductivity of graphite with no adjustable parameters is presented. The graphite crystal is treated as a set of noninteracting two-dimensional lattices and only in-plane vibrations are considered. The relaxation time is determined through the diagonal matrix elements of the scattering matrix. The anharmonicity coefficients are obtained from the thermodynamic equation of state with the use of the experimental data for the thermal expansion coefficient. The results are in qualitative agreement with the experiments. This calculation makes it possible, in principle, to analyze separately the contributions of the various branches and phonons to the heat transfer and to the scattering. (auth)

12744 THERMODYNAMIC INVESTIGATIONS IN THE SYSTEM NIOBIUM−MOLYBDENUM−NITROGEN. II. THERMODYNAMICS OF THE α SOLID SOLUTION. Hoerz, Gerhard; Steinheil, Eckart (Max-Planck-Institut fuel Metallforschung, Stuttgart). Z. Metallk.; 62: No. 12, 887-92(Dec 1971). (In German).

On the basis of experimental results published previously, a thermodynamic analysis of the α solid solution in the system Nb−Mo−N is presented. To this end reaction enthalpies and entropies, activity coefficients, excess partial quantities, and interaction coefficients were derived. The influence of additions of Mo or Nb on the nitrogen solution in Nb or Mo, respectively, can be described up to concentrations of 40 at. % by first order free energy, enthalpy, and entropy interaction coefficients. The nitrogen solution in Mo was influenced more strongly by additions of Nb in reverse to the nitrogen solution in Nb by additions of Mo. (auth)

12745 THERMODYNAMIC INVESTIGATIONS IN THE SYSTEM NIOBIUM–MOLYBDENUM–NITROGEN. III. ON THE PHASE DIAGRAM. Hoerz, Gerhard; Steinheil, Eckart (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 62: No. 12, 893-6(Dec 1971). (In German).

The phase relations in the metal-rich part of the Nb−Mo−N system are described. On the basis of the phase relations in the binary systems Nb−N, Mo−N, and Nb−Mo, which are discussed first, and with the aid of results published before and of literature data an isothermal section through the complete phase diagram of the Nb−Mo−N system was set up. (auth)

12746 ADVANTAGES AND PROBLEMS IN USING HIGH-PERFORMANCE FUELS IN FAST-BREEDER REACTORS. Gaboide, Jean (Europaeische Institut fuer Transurane, Karlsruhe, Ger.). Chem. Ztg.; 95: No. 6, 269-74(Mar 1971). (In German).

The mixed uranium−plutonium carbides, nitrides and carbonitrides are potential high-performance fuels for future advanced fast breeders. These fuels are compared with the better known mixed oxides, which are now finding worldwide utilization. The conclusion is drawn that the present state of knowledge does not preclude the utilization of these fuels. Well defined basic research coupled with technological development studies will lead to a safe, reliable, and economic pin design for the 2000 to 3000 MW(e) power stations of the future. (auth)

12747 VYSOKOTEMPERATURNAYA KHIMIYA OKISLOV URANA I IKH SOEDINENII. (High-Temperature Chemistry of Uranium Oxides and Their Compounds). Voronov, N. M.; Sofronova, R. M.; Voitekhova, E. A. Moscow; Atomizdat (1971). 360p.

A systematic treatment of the high-temperature chemistry of uranium compounds is presented. After a chapter devoted to the four oxides of U, successive chapters discuss in turn the high-temperature interaction of U oxides with oxides of the metals of Group I, Group II, Group III, Group IV, Groups V and VI, and Groups VII and VIII, respectively. There is an abundance of phase diagrams which depict the behavior of the various binary and

ternary systems: UO_x–UO_y and U_x–Me_y–O_z, where Me represents one of the metals from Groups I–VIII. (K.S.W.)

12748 THERMODYNAMIC AND COMPOSITION CHANGES IN $UO_{2\pm x}$ ($x < 0.005$) AT 1950 K. Wheeler, V. J.; Jones, I. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 42: No. 2, 117-21(Feb 1972).

The composition of $UO_{2\pm x}$ has been determined in a narrow range on either side of the stoichiometric composition, as a function of the equilibrium oxygen pressure at a single temperature, 1950°K. Samples of UO_{2-x} cooled rapidly from 1950°K to room temperature disproportionate to stoichiometric UO_2 and U metal. The significance of these results to the commercial sintering of UO_2 fuel pellets is discussed. (auth)

12749 THERMOMIGRATION OF BIPHASE VAPOR–LIQUID DROPLETS IN SOLIDS. Anthony, T. R.; Cline, H. E. (General Electric Research and Development Center, Schenectady, N. Y.). Acta Met.; 20: No. 2, 247-55(Feb 1972).

The thermomigration of biphase vapor–liquid droplets was studied in KCl as a function of droplet size and the relative proportions of gas and liquid phases in the droplets. Droplets containing more than 10 vol % of gas migrated down thermal gradients toward lower temperatures in contrast to the usual thermomigration behavior of simple gas or liquid inclusions up thermal gradients in solids. By considering viscous gas flow, vapor diffusion, liquid diffusion, evaporation, condensation, and liquid currents driven by surface tension gradients, the observed thermomigration behavior of biphase vapor–liquid droplets can be adequately explained. The results of this and previous investigations were applied to the thermomigration problems associated with the proposed storage of highly radioactive waste products in abandoned salt mines. The thermomigration of naturally occurring brine droplets in a salt formation up thermal gradients generated by the vigorous self heating of these nuclear wastes is shown to be capable of causing an undesirable inflow of water into the nuclear waste crypts. In addition, the thermomigration of contaminated vapor liquid droplets created on the salt crypt walls in a direction away from the crypt may lead to a modest dispersal of radioactive wastes in the salt formation. Droplet migration along the gravitational field or along the weak natural thermal gradient of the earth would be prevented by the trapping of droplets on grain boundaries in the salt. Thus, the escape of radioactivity to the outside environment is unlikely even on a geological time scale. (auth)

12750 IMPURITY DISTRIBUTIONS IN ANODIC FILMS ON TANTALUM. Pawel, R. E. (Oak Ridge National Lab., Tenn.); Pemsler, J. P.; Evans, C. A. Jr. J. Electrochem. Soc.; 119: No. 1, 24-9(Jan 1972).

Anodization of tantalum in electrolytes containing phosphorus or fluorine ions resulted in the incorporation of a quantity of these elements into the anodic film. While phosphorus was concentrated in the outer portions of such films, fluorine was attracted to the oxide/metal interface. An ion microprobe mass spectrometer (IMMS) was employed to examine the concentration profiles of these elements in films formed by a variety of anodization procedures. These experiments demonstrated the usefulness of the IMMS as a tool for such work and, in addition, furnished information on the characteristics of both film growth and the distribution and movement of these impurities. The influence of fluorine-rich layers at the oxide/metal interface on the adherence of the anodic films was also shown. (auth)

12751 THERMODYNAMIC MODEL FOR NON-STOICHIOMETRIC TERNARY CARBIDES. Hillert, Mats (Royal Inst. of Tech., Stockholm). Scr. Met.; 5: No. 12, 1067-71(Dec 1971).

The use of a thermodynamic model based upon a partition function containing parameters identified with the energies of various bonds by analyzing Hoch's data (J. Electrochem. Soc. (in press)) on the Zr–Nb–C system of the ideal composition Mc was demonstrated. The model is based upon the following free energy expression for one mole of MC, $G_m = y_A y_C {}^0G_{AC} + y_A y_D {}^0G_{AD} + y_B y_C {}^0G_{BC} + y_B y_D {}^0G_{BD} - TS_m^{ideal} + E_{G_m}$ where the concentration parameters are defined by $y_A = x_A/(x_A + x_B) = 1 - y_B$ and $y_C = x_C/(x_C + x_D) = 1 - y_D$. The ^0G parameters represent the free energies of the stoichiometric binary phases. It is pointed out that the model used in the evaluation of the thermodynamic properties of the Zr–Nb–C contains one parameter less than the model used by Hoch, counting the parameters required to describe the concentration dependence of the bond energies according to Hoch. The representation of the experimental data in terms of the new model is not inferior. Attempts to remove the discrepance by modifying the model were unsuccessful, and it is tentatively suggested that it is due to shortcomings in the experimental data. (P.C.H.)

12752 STATIC FATIGUE OF GRAPHITE. Wilkins, B. J. S. (Whiteshell Nuclear Research Establishment, Pinawa, Manitoba). J. Amer. Ceram. Soc.; 54: No. 12, 593-5(Dec 1971).

The static fatigue behavior of an extruded graphite was determined. The relation between time-to-rupture and the homologous fatigue stress (i.e., the ratio of the applied stress to the instantaneous fracture stress) is shown at two levels of applied stress. The significance of this relation is discussed, and its use in predicting cumulative fatigue damage is indicated. (auth)

12753 THERMODYNAMICS OF Re–O. Franco, J. I.; Kleykamp, H. (Kernforschungszentrum, Karlsruhe, Ger.). Ber. Bunsenges. Phys. Chem.; 75: No. 9, 934-8(Sep 1971). (In German).

The Gibbs energy of formation of orthorhombic ReO_2 has been determined by the emf method using the solid cell Fe, $FeO/ZrO_2 \cdot Y_2O_3/Re$, ReO_2, which is given by the equation $^f\Delta G_T^0\ \langle ReO_2\rangle = -104{,}840 + 43{,}200 \cdot T \pm 530$ [cal/mol] between 850 and 1130°K. The heat of formation and the standard entropy are calculated with $\Delta C_p = 3.14 + 1.08 \cdot 10^{-3} \cdot T - 2.69 \cdot 10^5 \cdot T^{-2}$ [cal/K · mol]: $^f\Delta H_{298}^0\ \langle ReO_2\rangle = -106.9 \pm 2.0$ kcal/mol, $S_{298}^0\ \langle ReO_2\rangle = 11.5 \pm 1.5$ cal/K · mol. The Gibbs energy of formation has been evaluated between 298 and 1300°K: $^f\Delta G_T^0\ \langle ReO_2\rangle = -107{,}570 - 5.16 \cdot T \cdot \log T + 61{,}400\ T \pm 1000$ [cal/mol]. The thermodynamic data of the rhenium oxides ReO_2, ReO_3, and Re_2O_7 are reviewed. (auth)

12754 LOW-TEMPERATURE HEAT CAPACITIES OF LANTHANUM HYDRIDE. Bieganski, Z. (Inst. for Low Temperature and Structural Research, Wroclaw). pp 177-9 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

The heat capacities of two samples of lanthanum dihydride of the compositions $LaH_{2.00}$ and $LaH_{2.03}$ were measured in the temperature range 60 to 340°K. The results showed that above 180°K the specific heats of both lanthanum dihydride samples exceed markedly those of the corresponding cerium dihydride and show flat and broad anomalies in the temperature range 170 to 270°K. The maximum of the anomaly for the sample of the composition $LaH_{2.00}$ was shifted to the higher temperature range as compared with that of $LaH_{2.03}$. Repeated annealing of the samples for several days did not change the results. The most probable reason for the anomalous behavior of the lanthanum dihydride seems to be the diffusion of interstitial hydrogen atoms through the crystal lattice of La. It was also noted that the heat capacities of lanthanum dihydride below 150°K were lower than the values for La metal. (P.C.H.)

12755 HEAT CAPACITY FROM 1 TO 350 K AND ENTHALPY OF FORMATION AT 298.15 K OF URANIUM DIBORIDE. Flotow, H. E.; Hubbard, W. N.; O'Hare, P. A. G.; Osborne, D. W.; Settle, J. L. (Argonne National Lab., Ill.). pp 197-202 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

The thermal capacity of UB_2 was measured by the isoperibol (isothermal) method between 0.84 and 21°K. Further measurements were made in an adiabatic apparatus between 7 and 350°K. Values for the entropy, enthalpy increment, and the Gibbs energy function were calculated from the thermal capacity data. The thermal capacity value was found to be 13.33 ± 0.03 cal K^{-1} $mole^{-1}$ at 298°K. (P.C.H.)

12756 ENTHALPY OF FORMATION OF BeH_2. Akhachinskii, V. V.; Kopytin, L. M.; Senin, M. D. (State Committee for Utilization of Atomic Energy, Moscow). pp 279-81 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

The enthalpy of formation, $\Delta H^0_{f\,298}$, of beryllium hydride, BeH_2, was found by the calorimetric measurements of heats of dissolution to be -4.60 ± 0.17 kcal $mole^{-1}$. (auth)

12757 THERMOCHEMICAL STUDIES OF THE Zr–O SYSTEM. Kornilov, A. N.; Ushakova, I. M. (Moscow State Univ.). pp 291-9 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

Problems involved in measuring the heat of combustion of ZrO_x (α-phase) samples of different compositions are discussed. They are divided into three types concerning the revision of some thermochemical concepts with respect to non-stoichiometric phases (percentage complete of combustion, sample formula), the chemical problems associated with studying the reactant sample and combustion products, and the methods of mathematical statistics to be resorted to in rational planning of experiments and processing of data. The ZrO_x (α-phase) thermodynamic functions of formation were calculated by combination of previous and present data. The values ΔG_f^0 (1,000°K, ZrO_x) were calculated as functions of composition by integrating the Gibbs–Duhem equation and using previous data. The values ΔS_f^0 (298°K, ZrO_x) were calculated by combining the resulting ΔG_f^0 (1,000°K, ZrO_x) data with the present ΔH_f^0 (298°K, ZrO_x). Data are tabulated. (P.C.H.)

12758 THERMODYNAMICS OF RARE EARTH–CARBON SYSTEMS. Balducci, G.; De Maria, G.; Guido, M. (Univ., Rome). pp 415-21 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

The present status of the thermodynamics of vaporization of the rare earth–carbon systems is summarized, taking into account the data so far obtained together with the results of others. From data available on the heats of formation along the lanthanide series, it was found that ΔH_{298}^0 $MC_2(s)$ are approximately constant for elements within the same subshell, the values being about –15 kcal mole^{-1} for Ce to Eu, and –19 kcal mole^{-1} for Gd to Lu. Trends for volatility and vapor composition, thermodynamics, and dissociation energies are also discussed. (P.C.H.)

12759 HEATS OF FORMATION OF LOWER ACTINIDE FLUORIDES FROM MASS SPECTROMETRIC STUDIES. Zmbov, K. F. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 423-7 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

A mass spectrometric study of high-temperature equilibrium reactions was used to determine heats of formation and bond dissociation energies of gaseous UF_4–Ca and ThF_4–Ca. The values of the free energy functions at 1300°F were –13.1 and –17.2 cal K^{-1} mole^{-1} for the reactions $UF_4(g) + Ca(g) = UF_3(g) + CaF(g)$, and $UF_4(g) + 2Ca(g) = UF_2(g) + 2CaF(g)$, respectively. The free energy functions for the reactions $Ca(g) + ThF_4(g) = CaF(g) + ThF_3(g)$ and $2Ca(g) + ThF_4(g) = 2CaF(g) + ThF_2(g)$ were estimated to be –14.6 and 20.0 cal K^{-1} mole^{-1}, respectively at 1300°K. Calculated equilibrium constants and heats of reactions are tabulated. (P.C.H.)

12760 THERMODYNAMICS OF SEVERAL LIGHT ELEMENT HIGH TEMPERATURE SPECIES. Farber, M.; Frisch, M. A. (Space Sciences, Inc., Monrovia, Calif.). pp 443-56 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

The molecular flow effusion method and a combined effusion-mass spectrometry method were used to measure the thermodynamics, such as entropy and heat of formation, of gaseous HBO, HOBO, B_2O_3, AlH, crystalline αAlB_{12}, and AlB_2, and Al. Data are tabulated. (P.C.H.)

12761 PHASE RELATIONSHIPS AND VAPORISATION BEHAVIOUR OF SOME SYSTEMS OF INTEREST IN NUCLEAR TECHNOLOGY. Potter, P. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 463-74 of Proceedings of the First International Conference on Calorimetry and Thermodynamics. Warsaw; Polish Scientific Publishers (1969).

From first international conference on calorimetry and thermodynamics; Warsaw, Poland (31 Aug 1969). See CONF-690834.

Some phase equilibria and vaporization behavior for the systems U–Pu–C, U–Pu–N, U–C–N, Pu–C–N, U–C–O, Pu–C–O, and U–Pu–C–O are discussed. The examples presented of the calculation of some equilibria showed that such treatments of phase diagrams can help both in the interpretation of experimental data and in the assessment of phase diagram data. (P.C.H.)

12762 DEPOSITION OF BORON NITRIDE LAYERS ON SILICON SUBSTRATES AND THEIR APPLICATION AS DIFFUSION SOURCES. Schnabel, H.-J.; Fleischer, F. (VEB Halbleiterwerk, Frankfurt am Main). Phys. Status Solidi (a); 8: No. 1, 71-8 (16 Nov 1971). (In German).

Boron nitride layers were deposited on silicon substrates by means of spark discharge. The layers used as diffusion source give well reproducible boron distributions with homogeneous surface concentrations. The quantity of boron to be diffused is determined only by a heat treatment in the range 850 to 950°C. Before diffusion, the boron nitride layers are removed from the substrate. The boron profiles correspond to a Gaussian distribution. Therefore, surface concentration and penetration depth may be determined by a four-probe method. (auth)

12763 STUDY OF THE DISPERSION-STRENGTHENING IN NICKEL–ZIRCONIA COMPOSITE MATERIALS. Sastry, D. H.; Vasu, K. I. (Indian Inst. of Science, Bangalore). Trans. Jap. Inst. Metals; 12: No. 6, 405-9(Nov 1971).

The low-temperature deformation behavior of nickel containing up to four volume percent zirconia was investigated by employing tensile tests and differential-stress creep experiments. At a given strain, the activation area decreased with increasing volume fraction of the dispersoid. The data on flow stress are not in quantitative agreement with the Orowan model for initial yielding and the Fisher–Hart–Pry mechanism for strain hardening. It is thought that the increase in flow stress and work hardening rate for the alloys may arise from the high initial dislocation density and its rapid increase with strain. The rate-controlling mechanism for deformation of zirconia-dispersed nickel appears to be the thermally activated intersection of dislocations. (auth)

12764 HYDRATION CHARACTERISTICS OF NEODYMIUM OXIDE AFTER SUBJECTION TO SHOCK. Adadurov, G. A.; Breusov, O. N.; Dremin, A. N.; Drobyshev, V. N. Zh. Neorg. Khim.; 16: No. 7, 2015-16(Jul 1971). (In Russian).

Neodymium oxide (Nd_2O_3) of 99.97% purity was roasted at 1,200°C for 2 hr, encapsulated in either Cu of Fe ampules, and then given a shock treatment using a charge of hexogen. The hydration rate of the material during exposure to water vapor at about 23°C was measured. The cooling treatment immediately following the roasting step was significant in the hydration behavior of a given sample. (K.S.W.)

12765 MASS SPECTROMETRIC INVESTIGATION OF C_2-EXCHANGE REACTIONS OF RARE EARTH METALS WITH THEIR DICARBIDES. Filby, Evan Everett. University Park, N. Mex.; New Mexico State Univ. (1971). 157p. University Microfilms Order No. 71-24,628.

Thesis.

A Knudsen-cell mass spectrometric method has been used to study C_2-exchange reactions of the type $M_aC_2(g) + M_b(g) = M_a(g) + M_bC_2(g)$, where M_a and M_b are two different rare earth metals. A total of eleven different combinations were studied including Ce–La, Ce–Pr, Pr–Nd, Ce–Nd, Ce–Gd, Gd–Tb, Tb–Dy, Ho–Dy, Er–Ho, Er–Tm, and Nd–Ho, and the dissociation energies of the gaseous dicarbides were determined from the enthalpies of the exchange reactions coupled with a known value (162 ± 2 kcal/mole) for the CeC_2 dissociation energy. These values are 160 ± 3 kcal/mole for LaC_2, 151 ± 3 kcal/mole for PrC_2, 144 ± 3 kcal/mole for NdC_2, 151 ± 3 kcal/mole for GdC_2, 150 ± 3 kcal/mole for TbC_2, 133 ± 4 kcal/mole for DyC_2, 134 ± 3 kcal/mole for HoC_2, 135 ± 3 kcal/mole for ErC_2, and 119 ± 4 kcal/mole for TmC_2. Trends in the heats of formation and sublimation of the rare earth dicarbides as a whole were used to estimate dissociation energies of 116 ± 7 kcal/mole for SmC_2, 98 ± 8 kcal/mole for EuC_2, 90 ± 10 kcal/mole for YbC_2, and 156 ± 12 kcal/mole for LuC_2—all of which agree with the trends noted in the measured dissociation energies. The dissociation energies show a double periodicity in their variation with atomic number which closely matches the variations of the dissociation energies of the rare earth monochalcogenides (MO, MS, etc.) and of the heats of sublimation for the rare earth metals. By analogy with the monoxide dissociation energies and the metal sublimation energies, the double periodic pattern of the dicarbide dissociation energies is shown to correspond to the magnitudes of the $4f^n \rightarrow 4f^{n-1}5d$ transition energies of the divalent rare earth ions. The success of this approach lends support to the consideration of the C_2^{2-} ion as a "pseudo-oxide" or, more generally, a "pseudo-chalcogenide." This pseudochalcogenide character is used to estimate dissociation energies for a number of other metal dicarbides. (Diss. Abstr. Int., B)

12766 INVESTIGATIONS ON THE NIOBIUM–OXYGEN–NITROGEN SYSTEM. I. PROPERTY CHANGES OF NIOBIUM BY SIMULTANEOUSLY DISSOLVED OXYGEN AND NITROGEN. Rothenbacher, Rolf; Skudelny, Gisbert; Gebhardt, Erich (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 62: No. 11, 787-91(Nov 1971). (In German).

The changes in the properties of niobium due to relatively high contents of both oxygen and nitrogen in solid solution were determined. Cooling rates of up to 870°C/s made it possible to hold

in solution gas mixtures with total concentrations of up to 6.5 at. %. The nitrogen content varied between 0 and 1.0 at. %. The additional electrical resistivity, $\Delta\rho$, caused by the dissolved oxygen increases linearly up to a content of 6.5 at. %. It amounts to 4.4 $\mu\Omega$cm per at. %. If nitrogen and oxygen are dissolved together, $\Delta\rho$ increases less strongly, and the increase is linear with the gas content only up to 4.4 at. % ($\Delta\rho$ = 3.9 $\mu\Omega$cm per at. %). $\Delta\rho$ in this case increases somewhat more strongly between 4.4 and 6.5 at. % ($\Delta\rho$ = 5.7 $\mu\Omega$cm per at. %) than in the case of Nb–O. The hardness depends on the amount of gas in solution as well as on gas composition. With a constant gas content in solution the hardness increases with increasing percentage of nitrogen in the gas. The rate of oxygen absorption of pure niobium is markedly reduced if nitrogen is dissolved in the niobium at first. The retarding influence of the nitrogen content increases considerably with decreasing temperature. At 1120°C the absorption rate is reduced by 50% as compared with that of a sample which is free of nitrogen. (auth)

12767 ADSORPTION OF XENON, KRYPTON, AND METHANE ON ACTIVE CHARCOAL AT LOW PRESSURES AND TEMPERATURES. Gruetter, A.; Shorrock, J. C. (Battelle Memorial Inst., Geneva). pp 149-55 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

A new experimental technique for the direct measurement of the adsorption isosteres of krypton, xenon, and methane on activated coconut charcoal is described. The results obtained are analyzed to yield information on the behavior of the adsorbed layer on passing through the triple point temperature. Some methane isosteres indicate that a phase change of the adsorbed layer takes place. No such behavior was found for xenon or krypton. The results are presented in a form suitable for the calculation of adsorption data over a wide range of temperatures and partial pressures. The Dubinin potential theory [Chem. Rev. 60: 235(1960)] is successful both in correlating the experimental data and in reducing the triple point isotherms to a single representation. (auth)

12768 DETERMINATION OF THE EFFECTIVE CO/CO_2 DIFFUSION COEFFICIENT IN NUCLEAR GRAPHITE: ANALOGY BETWEEN GASEOUS DIFFUSION AND ELECTRICAL CONDUCTION. Blanchard, R.; Lang, F. M.; Marmonier, S.; Ranc, R. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). pp 197-9 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

The effective diffusion coefficient of two gases in a porous body can be determined directly or indirectly by an analogous method. The direct measurement described has the advantage of simplicity and rapidity. Measurement by analogy between gaseous diffusion and electrical conduction is of definite theoretical interest, but is difficult to carry out because of the conducting properties of graphite. For the capillary network filling it is necessary to use highly conducting solids. (auth)

12769 INTERNAL FRICTION OF CARBONS AND GRAPHITES. Gobin, P. (Institut National des Sciences Appliquees, Lyon); Merlin, J.; Rouby, D.; Jouquet, G.; Rappeneau, J. pp 369-72 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971). (In French).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

The coefficient of internal friction was measured on a range of carbon materials, using a torsion pendulum at frequencies around 1 Hz. Its development was determined for strains from 10^{-5} to 2×10^{-3}, in the temperature range –180 to 500°C. The behavior of these materials suggested two main processes of energy absorption: a continuous background which can be related to strain by a hyperbolic relationship and increases slightly with temperature; and a peak at about 0°, which appears to be a hysteresis peak and is analyzed using the Granato–Lücke model. [J. Appl. Phys. 27: 583 (1956)]. Different treatments may induce changes in these two components: graphitization, neutron irradiation, annealing, thermomechanical treatments. The level of the continuous background rises with the degree of graphitization; it is reduced by small neutron doses. The amplitude of the peak is higher the lower the degree of graphitization. Irradiation diminishes this amplitude and displaces the peak to higher temperatures. Several mechanisms are invoked to account for the observed effects: dislocation movements, interactions between dislocations and point defects and between microcracks and point defects. (auth)

12770 ROLE OF INTER-PARTICLE BOND STRENGTHS ON THE LIFE OF COATED PARTICLE FUEL. Williamson, G. K.; Ashford, J. P. (Central Electricity Generating Board, Berkeley, Eng.). pp 390-3 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

There are basically two ways in which coated particles are consolidated to make acceptable fuel material for nuclear fuel elements: to embed them in a protective matrix (the matrix concept) or, to cement an array of loose particles together at their points of contact (the bonded frit concept). The importance of bond strengths and their integrity to the bonded frit concept is discussed in terms of endurance characteristics for particulate fuel. High-modulus bonds are shown to be detrimental to the required particle performance, and low-strength bonds are less likely to retain all the particles in the event of a fracture. The weak bonded matrix concept, in which the particles are protected from all external stresses, is the most appropriate development for use with the UK clean circuit philosophy. (auth)

12771 FACTORS INFLUENCING THE STRENGTH OF COMPOSITE FUEL BODIES. Ashford, J. P. (Central Electricity Generating Board, Berkeley, Eng.). pp 396-404 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

The factors influencing the strength and elastic behavior of composite fuel bodies are reviewed and the importance of micromechanical stresses caused by different elastic properties of the separate phases is discussed. Fracture studies on 4-point bending beams were used to assess strength and elastic properties of composite fuel bodies with volumetric loading of 0, 20, and 35% of UO_2 microspherical coated particles. The integrity of the coated particle fuel does not appear to be influenced by crack propagation through the matrix. (auth)

12772 PHYSICAL PROPERTIES OF METAL-IMPREGNATED GRAPHITE. Lanza, F.; Burg, H.; Giuliani, S.; Hoepper, M.; Marengo, G. (CCR-EURATOM, Ispra, Italy). pp 405-10 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

It is stated that impregnation of graphite with metals of suitable nuclear properties can lead to materials of interest for structural parts of nuclear reactors and for fuel element cannings. A fine-grain graphite impregnated to >70% of the open porosity is stated to give a completely impervious material. A review is presented of the properties of this class of material. Consideration is given to dimensional stability, mechanical strength, and thermal conductivity. (UK)

Structure and Phase Studies

Refer also to abstracts 12627 and 12697.

12773 (HEDL-SA-269) EQUILIBRIUM OXYGEN POTENTIAL COMPOSITION RELATIONSHIPS IN $U_{0.75}Pu_{0.25}O_{2-x}$. Woodley, R. E. (Hanford Engineering Development Lab., Richland, Wash.). [1970]. Contract AT(45-1)-2170. 14p. (CONF-711030-5). Dep. NTIS.

From twenty-fourth Pacific Coast regional meeting of the American Ceramic Society; Anaheim, Calif. (30 Oct 1971).

Results of a study in which the range of thermodynamic data on the mixed uranium–plutonium oxides were extended to a material containing 25 wt% PuO_2 and temperatures to 1400°C are presented. The data from these gas-solid equilibrium measurements are not entirely in agreement with previously available data, but the differences should be clarified by additional studies currently in progress. (auth)

12774 INVESTIGATION OF THE UO_2–WO_3 SYSTEM. Rozanova, O. N.; Kovba, L. M.; Trunov, V. K. Sov. Radiochem. (Engl. Transl.); 13: No. 2, 317-18(Mar-Apr 1971).

Translated from Radiokhimiya; 13: No. 2, 307-9(Mar-Apr 1971).

X-ray diffraction studies were made on UO_2–WO_3 systems. They indicated a new phase, $U_5W_{19}O_{67}$. (M.C.G.)

12775 PHASE STUDY ON THE TIE LINE OF U_3O_7–PuO_2. Nakayama, Yasuyuki (Japan Atomic Energy Research Inst., Tokai). J. Inorg. Nucl. Chem.; 33: No. 12, 4077-84(Dec 1971).

A phase diagram of the tie line of $U_3O_7-PuO_2$ was constructed for all concentrations of plutonium and for temperatures between 350° and 800°C from results obtained using a thermobalance and an x-ray diffractometer. It was found by air oxidation that a mixed oxide solid solution proceeds through two-step oxidation up to 30 at. % plutonium. At the end of the first step, the value of the oxygen-to-uranium ratio was about 2.36 which corresponds to the formula, $U_yPu_{1-y}O_{2+0.36y}$, for $y > 0.7$ and exists on the tie line of $U_3O_7-PuO_2$. Upon heating, the $U_yPu_{1-y}O_{2+0.36y}$ oxide was a tetragonal phase up to 400°C, two phases (tetragonal and orthorhombic) up to 600°C, and two phases (fcc and orthorhombic) at 800°C, for $y > 0.8$. It was found that the phase boundaries on the tie line of $U_3O_7-PuO_2$ were the same as for the U–O system. Therefore, it is concluded that the phases on the U–O system extend into the U–Pu–O system at least in the range of $0.8 > y > 0.7$. (auth)

12776 PRECIPITATION OF ZIRCONIUM HYDRIDE IN ZIRCONIUM AND ZIRCALOY-2. Bradbrook, J. S.; Lorimer, G. W.; Ridley, N. (Univ. of Manchester, Eng.). J. Nucl. Mater.; 42: No. 2, 142-60(Feb 1972).

The precipitation of zirconium hydride in iodide zirconium and Zircaloy-2 has been studied using, primarily, thin foil electron microscopy. The precipitate crystal structure and distribution has been found to be a function of heat treatment procedure. At rates of cooling of <2°C/min, large precipitates of the equilibrium fcc δ-hydride formed mainly at grain boundaries. As the cooling rate was increased intragranular precipitates became more evident. On cooling at 2 to 10°C/min the precipitates were mainly δ-hydride, but at rates greater than 10°C/min the fct γ-hydride became increasingly predominant. These δ- and γ-precipitates were internally twinned. Specimens rapidly quenched to room temperature contained only untwinned γ-hydrides. The orientation relationships between the hydrides and the matrix were measured. Hydrides formed under stress in Zircaloy tubing were observed to have similar structures and morphologies to those reported for unstressed material, although the precipitate distribution differed. A martensitic mechanism is proposed for the formation of twinned hydride and twinned and untwinned γ-hydrides, and its implications for the precipitation behavior of hydrides in the can of a reactor fuel element are outlined. (auth)

12777 SYSTEM TANTALUM–RHENIUM–BORON. Kuz'ma, Yu. B.; Lakh, V. I.; Stadnyk, B. I.; Chaban, N. F. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 9, 849-51 (Sep 1971). (In Ukrainian).

The system Ta–Re–B was investigated by means of x-ray analyses and the phase equilibria at 1400°C were established. The compound Re_3B dissolves 5 at.% Ta, Re_7B_3–12 at.% Ta, and ReB_2–less than 5 at.% Ta. The new ternary compounds— $Ta_3Re_3B_4$ with a tetragonal structure of the U_3Si_2 type ($a = 5.989 + 0.005$, $c = 3.282 + 0.003$ Å) and ~$TaReB_3$ with an unknown structure— were found. (auth)

12778 THERMOCHEMICAL PROPERTY OF $Fe_2O_3.2V_2O_5$ IN THE Fe_2O_3–V_2O_5 SYSTEM. Otsubo, Yoshio; Utsumi, Kazuaki (Waseda Univ., Tokyo). Nippon Kagaku Zasshi; 92: No. 8, 737-8(Aug 1971). (In Japanese).

The phase in the system $Fe_2O_3-V_2O_5$ was investigated by differential thermal analysis and x-ray diffraction analysis. In the system two compounds, $Fe_2O_3 \cdot V_2O_5$ and $Fe_2O_3 \cdot 2\,V_2O_5$, were stable. The compound $Fe_2O_3 \cdot 2\,V_2O_5$ was obtained when vanadium pentoxide was treated with hematite at 640°C for 5 hr. It melted incongruently at 715°C. (auth)

12779 DISLOCATION NODES IN BORON CARBIDE, WITH SPECIAL REFERENCE TO NON-STOICHIOMETRY. Ashbee, K. H. G.; DuBose, C. K. H. (Oak Ridge National Lab., Tenn.). Acta Met.; 20: No. 2, 241-5(Feb 1972).

Three structurally different kinds of dislocation nodes have been observed in crystals of boron carbide having the approximate composition B_4C. All three involve extended dislocations, and order of magnitude estimates for the specific translation twin boundary energy have been made from their geometrical shapes. Assuming that the stoichiometric composition for the boron carbide phase is $B_{13}C_2$, a translation twin model is proposed for the accommodation of hyperstoichiometry. (auth)

12780 DEFORMATION OF HYPERSTOICHIOMETRIC UO_2 SINGLE CRYSTALS. Yust, C. S.; McHargue, C. J. (Oak Ridge National Lab., Tenn.). J. Amer. Ceram. Soc.; 54: No. 12, 628-35(Dec 1971).

Hyperstoichiometric UO_2 single crystals having O/M ratios from 2.06 to 2.10 were deformed in compression. The active slip plane for deformation, as evaluated from slip traces, has an orientation between {112} and {111}. The critical resolved shear stresses for hyperstoichiometric specimens were approximately the same as those for stoichiometric specimens; the dislocation structures, as revealed by transmission electron microscopy, however, were very different and suggest more rapid motion and/or climb of dislocations in the hyperstoichiometric samples. The response to strain rate changes during deformation also reflected the difference in deformation behavior of hyperstoichiometric and stoichiometric crystals. (auth)

12781 X-RAY AND THERMAL-EXPANSION STUDY OF AN $(Na_{0.88}Li_{0.12})NbO_3$ + 6 MOL % Li_2O CERAMIC. Nitta, Tsuneharu; Miyazawa, Toshihiko (Matsushita Electric Industrial Co. Ltd., Osaka). J. Amer. Ceram. Soc.; 54: No. 12, 636-7(Dec 1971).

Powder diffraction patterns of the $(Na_{0.88}Li_{0.12})NbO_3$ + 6 mole % Li_2O_3 system were obtained using a goniometer and a Geiger–Mueller counter. Compositions containing >2 mole % Li_2CO_3 showed a new perovskite phase in addition to that previously reported in $Na_{0.88}Li_{0.12}NbO_3$. In the x-ray patterns of the solid solution, the main diffraction lines were accompanied by superlattice lines, which were reflections of indexes $(3\bar{1}1)$, $(\bar{3}31)$, $(5\bar{1}1)$, (531), $(5\bar{3}1)$, and $(5\bar{3}3)$. The multiple-cell rhombohedral parameters at 20°C calculated from the main diffraction lines (310) and (310) were $a_0 = 3.900$ Å X2 and $\alpha = 89°05'$. Thus it was concluded that addition of Li contributes to the formation of a perovskite phase with a rhombohedral subcell. Thermal expansion was measured using a standard dilatometer. Specimens 4 mm in diameter and 20 mm long were held in a quartz holder. The slope of the thermal expansion curve changed abruptly, corresponding to the occurrence of the high temperature structural modifications. Data are tabulated. (P.C.H.)

12782 MORPHOLOGY OF BORON CARBIDE SINGLE CRYSTALS. Sugaya, T. (Ohkura Electric Co., Tokyo); Watanabe, O. J. Less-Common Metals; 26: No. 1, 25-31(Jan 1972).

Single crystals of boron carbide ($B_{12}C_3$) were grown, generally, in a plate-like structure and/or in a prismatic structure by the carbon-arc reduction method, from B_2O_3. The preferential growth directions and planes for these single crystals are ⟨1$\bar{1}$3⟩, and {011}, {$\bar{1}$12}, and {001}, respectively, in the pseudo-hexagonal representation. The habits of the single crystals were systematically investigated. They were found to exhibit brittle behavior occurring along cleavage planes of {012}. The surface structure of the single crystals is discussed. (auth)

12783 STUDIES OF THE TERNARY SYSTEM URANIUM–CARBON–RARE EARTHS (Ce, Nd, La). Lorenzelli, Nicole; Marcon, Jean Pierre (CEN, Fontenay-aux-Roses, France). J. Less-Common Metals; 26: No. 1, 71-9(Jan 1972). (In French).

Lattice parameter measurements of uranium monocarbide containing various amounts of each of the rare earth elements: cerium, neodymium, and lanthanum, have been performed and used for an accurate determination of their solubility limits in various phase fields. In the case of cerium, the limits obtained were less than those reported in the literature. The following phase diagrams U–Ce–C, U–Nd–C, U–La–C have been carefully investigated by this method; some thermodynamic data concerning cerium carbides have thus been derived. (auth)

12784 INVESTIGATION OF THE ZIRCONIA–GADOLINIA SYSTEM. Negro, Alfredo; Amato, Ignazio (Politecnico, Turin). J. Less-Common Metals; 26: No. 1, 81-8(Jan 1972).

The effects of adding up to 50 mole % of gadolinia on the transformation of zirconia have been investigated by differential thermal analysis and x-ray diffraction. Zirconia and gadolinia ceramic grade powders, suitably homogenized, have been submitted to a solution heat treatment at 1450°C for 10 hr in air. The results indicated that the solution of a small amount of gadolinia in zirconia increases the thermal hysteresis of the zirconia tetragonal–monoclinic transformation, that the presence of 30 mole % or more of gadolinia stabilizes the zirconia in the cubic form, and that the presence of zirconia hinders the cubic–monoclinic transformation of residual gadolinia. The properties of powders obtained after solution treatment should enable them to be sinterable to dense bodies. (auth)

12785 LIQUIDUS DETERMINATIONS IN THE 15% SiO_2 PLANE OF THE QUATERNARY SYSTEM $CaO-Nb_2O_5-TiO_2-SiO_2$. Jongejan, A.; Wilkins, A. L. (Dept. of Energy, Mines, and Resources, Ottawa). J. Less-Common Metals; 26: No. 1, 89-98(Jan 1972).

Liquidus temperatures in the 15% SiO_2 plane of the $CaO-Nb_2O_5-TiO_2-SiO_2$ phase tetrahedron have been determined using the customary quench technique as well as hot-stage microscopy. The boundaries between the phase fields of $CaO \cdot TiO_2$, TiO_2, SiO_2, $CaO \cdot Nb_2O_5$, $2CaO \cdot Nb_2O_5$, $2CaO \cdot SiO_2$, and $3CaO \cdot SiO_2$ have been partly outlined. Only a very small area of intersection with the $CaO \cdot TiO_2 \cdot SiO_2$ phase space remains at the 15% SiO_2 level.

Although it was possible to outline the perovskite–pyrochlore boundary, the number of determinations was insufficient to establish definitely the non-existence of a small $8CaO \cdot 7Nb_2O_5 \cdot 6TiO_2$ field at the 15% SiO_2 level. Phase relations in the high-lime part of this plane appeared to be complex, possibly due to the presence of fields of calcium titanates, and these have not been included in the study. (auth)

12786 HECTOBORIDE PHASES OF LANTHANIDES AND ACTINIDES. Schwetz, K.; Ettmayer, P.; Kieffer, R.; Lipp, A. (Technische Hochschule, Vienna. Elektroschmelzwerk GmbH, Kempten, Ger.). J. Less-Common Metals; 26: No. 1, 99-104(Jan 1972). (In German).

New hectoboride phases of the rare earth metals and thorium have been prepared by arc melting alloys with a metal to boron ratio between 1:50 and 1:100. The lattice parameters and the Knoop hardness values of the hectoboride phases have been determined. The composition of the hectoborides of dysprosium and thorium has been analyzed. Only metals with atomic radii between $1.73 < R_M < 1.82$ Å are likely to form stable hectoborides. (auth)

12787 PHASE STUDY OF THE NIOBIUM–TELLURIUM SYSTEM IN THE COMPOSITION RANGE FROM Nb_2Te_7 TO Te. Smith, Douglas L.; Mochel, Allan R.; Banewicz, John J.; Maguire, John A. (Southern Methodist Univ., Dallas). J. Less-Common Metals; 26: No. 1, 139-44(Jan 1972).

The vapor pressures of various compositions in the tellurium-rich region of the niobium–tellurium phase system were determined at temperatures from 362.5 to 700°C, using the Knudsen effusion method. In the composition range from Nb_2Te_7 to elemental Te, three solid solutions and the compounds Nb_2Te_7, Nb_2Te_8, and $NbTe_3$ were found. The values of $\Delta H°$ and $\Delta S°$ for the different phase transformations are tabulated. (auth)

12788 PHASE RATIOS IN THE SYSTEM Nd_2O_3–SiO_2. Toropov, N. A.; Kougiya, M. V. (Giprotsement, Leningrad). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 7, 1082-4(Jul 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 7, 1220-3(Jul 1971).

Studies were made on the system Nd_2O_3–SiO_2 in the range of compositions from 58 to 84 wt % Nd_2O_3 in the subsolidus region. It was found that the system contains two stoichiometric compounds of 1:1 and 1:2 composition and has a region of homogeneity from 77 to 82 wt % Nd_2O_3 with an apatite-type structure. (auth)

12789 X-RAY DIFFRACTION OF UC–UC_2 AND UC–UN ALLOYS AT ELEVATED TEMPERATURES. Benz, R.; Farr, J. D. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater.; 42: No. 2, 217-22(Feb 1972).

Unit-cell dimensions of U–C–N alloys were measured at temperatures of 760 to 2250°C with an x-ray diffractometer. Lattice dimensions of the face-centered cubic phase in both the UC–UC_2 and UC–UN solutions were found to be linear functions of the UC mole fraction. In carbon saturated body-centered tetragonal α-UC_2 between 1000 and 1400°C, a small but distinct decrease in rate of volume change (slope) occurred with increasing temperature. The data suggest that the C/U ratio in α-UC_2 at 1000°C and below is 1.97 ± 0.03, a value in excess of that prevailing in carbon-saturated α-UC_2 at higher temperatures. (auth)

12790 CUBIC VANADIUM MONOXIDE. Reuther, H.; Brauer, G. (Univ., Freiburg i Br.). Z. Anorg. Allg. Chem.; 384: No. 2, 155-9(Aug 1971). (In German).

Reinvestigation of the homogeneity range of the cubic vanadium monoxide phase showed that this oxide exhibits two closely related phase sections ($VO_{0.86}$ to $VO_{0.91}$ and $VO_{1.05}$ to $VO_{1.25}$) divided by a miscibility gap. This largely confirms observations of Vol'f et al. (auth)

12791 REASSESSMENT OF THE COPPER–BORON PHASE DIAGRAM. Rao, M. V.; Anderson, R. N. (Parlee-Anderson Corp., Burlingame, Calif.). J. Less-Common Metals; 25: No. 4, 427-30(Dec 1971).

Inconsistencies in an earlier partial Cu-B phase diagram are noted. Results of a study in which the carbothermic reduction of reactive metal oxides using appropriate solvent metals to lower the chemical activity of the reduced metal and to prevent carbide formation are discussed. An apparatus was used to monitor the reactions and detect reaction termination points. It was concluded that the Cu–B phase diagram is a simple eutectic whereas the earlier data was interpreted as establishing the eutectic in the Cu-rich end. (J.R.D.)

12792 LIQUIDUS DETERMINATIONS IN THE PLANE CaO. Nb_2O_5–CaO.SiO_2–TiO_2 WITHIN THE QUATERNARY SYSTEM CaO–Nb_2O_5–TiO_2–SiO_2. Jongejan, A.; Wilkins, A. L. (Dept. of Energy, Mines, and Resources, Ottawa). J. Less-Common Metals; 25: No. 4, 345-51(Dec 1971).

Liquidus temperatures of compositions in the plane $CaO \cdot Nb_2O_5$–$CaO \cdot SiO_2$–TiO_2 have been determined using the customary quench technique as well as hot-stage microscopy. The boundaries between the fields of the following compounds have been outlined: TiO_2 (rutile), $CaO \cdot TiO_2 \cdot SiO_2$ (sphene), $8CaO \cdot 7Nb_2O_5 \cdot 6TiO_2$, $CaO \cdot Nb_2O_5$, $3CaO \cdot Nb_2O_5 \cdot 3TiO_2$(pyrochlore), $CaO \cdot TiO_2$ (perovskite) and $CaO \cdot SiO_2$ (pseudo-wollastonite). The pyrochlore and perovskite fields were wedged in between the others and both intersected the $CaO \cdot TiO_2 \cdot SiO_2$–$CaO \cdot Nb_2O_5$ join. (auth)

12793 STUDY OF THE H–X TRANSFORMATION OF SESQUIOXIDES OF Tb AND Dy AT HIGH TEMPERATURES. Badie, J. M. (CNRS, Montlouis, France). Compt. Rend., Ser. C; 273: No. 16, 932-4(18 Oct 1971). (In French).

High-temperature x-ray diffraction studies of the sesquioxides of Tb and Dy demonstrated that these oxides possess a cubic form, near to their fusion temperatures, which is similar to that observed with the first oxides of the lanthanide series. (France)

12794 APPLICATION OF THE THEORY OF THERMAL CONDUCTIVITY OF POLYCRYSTALLINE GRAPHITE TO THE ESTIMATION OF CRYSTALLITE SIZE L_a IN A RANGE OF MATERIALS McNerney, S.; Kelly, B. T. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 36-9 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

The theory of thermal conductivity developed in previous papers was applied to a range of polycrystalline graphites. Values of the crystallite size L_a and porosity —orientation–tortuosity factor α_x were derived for each of the samples. The L_a values obtained were checked independently by comparing the temperature T_m of the peak conductivity for a given L_a with similar data on a range of pyrolytic graphites studied previously. The agreement was found to be satisfactory. (auth)

12795 CONICAL MICROSTRUCTURES FORMED BY OXIDATION OF POLYCRYSTALLINE GRAPHITE. Jones, S. S. (Battelle-Northwest, Richland, Wash.). pp 238-45 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

The formation of a cone-shaped microstructure by graphite removal was observed in certain nuclear graphites, apparently for the first time. The cone structures were produced in TSX and AGOT graphite by electronically excited reactions involving oxygen, carbon dioxide, and/or water vapor. The required electronic excitation was produced in the glow region of the microwave-excited gases as well as by intense gamma radiation fields. These cone structures were formed with a wide range of span angles and with the principal cone axis perpendicular to the graphite basal planes. Cones were produced more efficiently at low gas pressure than at high pressure. It appears that transient species, with a lifetime of less than 10 msec, are responsible for cone formation and that the concentration of these oxidants is diminished, possibly by charge neutralization or recombination, as the gas pressure is increased. Experiments involving reactions with electrically charged graphite specimens indicated that the species responsible for cone formation has a negative charge. Another factor related to the mechanism of cone formation is the small element of impurity always found at the tip of each cone. It appears that such impurity units inhibit oxidation in their immediate vicinity in a controlled manner so as to produce the observed microstructures. Various stages in the development of cone structures were examined. The initial stages can be observed at less than 0.5% weight loss. Cones and impurities become visible when a cone height of about 100 A is attained. After 5% weight loss cone heights range from 100 to 5000 A and the size distribution does not appear to change with graphite removal up to at least 30% weight loss. As cones are removed by oxidation, impurities initially at the cone tips tend to collect in configurations which are related to the initial distribution pattern of the impurity in the original graphite. The lace network structures which result from continued graphite oxidation are thus found to consist of various aggregates of impurities. (auth)

Radiation Effects

Refer also to abstracts 11719, 12191, and 13411.

12796 (AECL-3952) GAMMA SPECTROMETRY OF IRRADIATED REACTOR FUELS. Experience at the Whiteshell Nuclear Research Establishment. Boase, D. G.; Chen, J. D.; Felawka, L. T. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Oct 1971. 24p. (CONF-710824-1). Dep. NTIS (U. S. Sales Only). AECL $1.00.

From Meeting on the development of gamma spectrometry instrumentation and techniques for safeguards; Vienna, Austria (30 Aug 1971).

Gamma spectrometric studies of irradiated fuel pins of a variety of types have been conducted at Whiteshell Nuclear Research Establishment using an automatic scanning unit and solid state detectors. Results are presented on axial and radial scans performed to yield information on the fine structure of fission distribution in fuel assemblies consisting of 18 fuel elements held together in a cylindrical bundle. A non-destructive scanning technique is described which yields quantitative data on the radial fission gradients in single pins. An example of the quantitative determination of burnup by γ-spectrometry is described and compared with destructive chemical analysis. A theoretical and experimental study of the value of ^{137}Cs as a fission monitor in CANDU fuels is briefly described, and the joint application of γ-spectrometry and reactor physics to the improved calculation of the plutonium content of irradiated fuels is explored. (auth)

12797 (EUR-4698) REPLICA ELECTRON MICROSCOPY OF IRRADIATED FUELS. Remarks on the Method. Ronchi, C.; Bazior, E.; Kostecka, H. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). Aug 1971. 22p. Dep. NTIS (U. S. Sales Only). EUR FF 4.45.

The application of the replica technique and electron microscopy to the analysis of irradiated fuels is discussed with respect to the experimental technique. The most suitable replication methods for the various observable features are established on the basis of results obtained by the examination of irradiated fast reactor fuels. (auth)

12798 INFLUENCE OF TEMPERATURE ON STRUCTURAL CHANGES OF ^{238}Pu DIOXIDE DURING SELF-IRRADIATION. Kapshukov, I. I.; Sudakov, L. V.; Yakovlev, G. N. At. Energ. (USSR); 31: No. 6, 630-1(Dec 1971). (In Russian).

Changes in the crystalline lattice of the dioxide of ^{238}Pu were measured under the effects of internal irradiation at the temperature of liquid nitrogen, room temperature, and at 500°C. Parameter changes were more rapid during the first six days of observation; during the subsequent twelve days of irradiation a plateau was essentially reached. X-ray studies showed that the liquid nitrogen samples manifested nearly twice the radiation damage that samples at 500°C exhibited. (K.S.W.)

12799 INCREASED LIFETIME OF GRAPHITES IRRADIATED ABOVE 1200°C. Gray, W. J. (Battelle-Northwest, Richland, Wash.); Pitner, A. L. Carbon; 9: No. 6, 699-710(Dec 1971).

For several nuclear graphites, the fluence required to contract to a minimum volume and expand back to the original volume is much greater at 1250°C than for temperatures near 1000°C. This occurs because, at the higher temperature, the graphite initially contracts to a smaller minimum volume and its expansion rate following the minimum volume is lower. The mechanism for this is believed to be an increased irradiation creep constant that allows plastic deformation rather than fracture to accommodate the differential crystal strains. Data for two nuclear graphites show that the fluence corresponding to the minimum graphite volume is nearly temperature independent in the range 400 to 800°C, but then quickly decreases to about half the low-temperature value for the range 950 to 1300°C. Arguments are presented to show that similar behavior is to be expected for most nuclear graphites. The saturation electrical resistivity is about double the unirradiated value for irradiation temperatures over the entire range 400 to 1000°C but only about 1.5 times the unirradiated value for irradiation temperatures near 1250°C. The difference is apparently related to the decrease that occurs upon annealing at temperatures above 1200°C. (auth)

12800 HIGH DOSE FAST NEUTRON IRRADIATION OF HIGHLY ORIENTED PYROLYTIC GRAPHITE. Kelly, B. T.; Brocklehurst, J. E. (United Kingdom Atomic Energy Authority, Salwick, Eng.). Carbon; 9: No. 6, 783-9(Dec 1971).

Highly oriented samples of well graphitized pyrolytic graphite were irradiated to doses of 2.5×10^{22} nvt (Dido Equivalent Dose) at temperatures between 250 and 470°C. Measurements were made of the changes in dimensions parallel and perpendicular to the deposition planes, density, thermal expansion coefficients parallel and perpendicular to the deposition plane and thermal conductivity parallel to the deposition planes. Samples of the same type but with varying crystallite perfection, and of high perfection doped with boron were irradiated at temperatures of 900 to 1200°C to study the effects of crystallinity and doping on dimensional changes. (auth)

12801 EFFECTS OF FAST-NEUTRON IRRADIATION ON TENSILE STRENGTHS OF CARBON FIBERS. Bullock, R. E. (General Dynamics, Fort Worth, Tex.). Radiat. Eff.; 11: No. 2, 107-12(Nov 1971).

Two types of commercially available carbon fibers (high tensile strength (HTS) and high modulus (HMS)) were irradiated in the Ground Test Reactor in environments of air and of liquid nitrogen (LN_2). The tensile strength of HTS fibers irradiated in air increased sharply above a fast-neutron fluence of 6×10^{17} n/cm^2 (E > 1 MeV) and was 17% greater than the strength of unirradiated control fibers at a fluence of 8.5×10^{17} n/cm^2, but then the strength began to decrease for additional neutron exposure in air and fell 25% below the control strength at the highest fluence of 4.5×10^{18} n/cm^2. However, when irradiated in LN_2 where surface oxidation did not take place, the room-temperature strength of HTS fibers continued to increase beyond 8.5×10^{17} n/cm^2 and became almost 30% greater than the control strength for a fluence of 3×10^{18} n/cm^2. The tensile strength of HMS fibers irradiated in air increased slowly but steadily with neutron exposure and was only 4% greater than the control strength at the highest fluence of 4.5×10^{18} n/cm^2; the room-temperature strength of the HMS fibers decreased by 13% when irradiated to a fluence of 3×10^{18} n/cm^2 in LN_2. (auth)

12802 DESORPTION STUDIES ON NUCLEAR GRAPHITE. Ashton, B. W.; Labaton, V. Y.; Smith, A. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 329-38 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

The gases desorbed from three nuclear graphites in the as-received state and after irradiation in $CO/CH_4/CO_2$ coolants were identified and measured. The results are examined in terms of the effects of graphite type, and the importance of surface complexes in inhibition of the radiolytic graphite/CO_2 reaction. (auth)

12803 ANALYSIS OF IRRADIATION CREEP IN REACTOR GRAPHITE. Kelly, B. T.; Brocklehurst, J. E. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 363-8 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

A model for the irradiation creep of graphite, assuming the deformation arises from basal shear, is considered, and the conclusions from the analysis are compared with observed data on a wide range of materials. A correlation of graphite creep data from different sources in terms of the elastic behavior of the materials is demonstrated, and it is shown that changes in Young's modulus due to changes in the structure of the graphite aggregate (e.g., by radiolytic oxidation) will affect the irradiation creep rate in the way predicted. (auth)

12804 SIMPLE MODEL DESCRIBING THE PHYSICAL PROCESSES WHICH DETERMINE COATED PARTICLE LIFE. Williamson, G. K.; Horner, P. (Central Electricity Generating Board, Berkeley, Eng.). pp 383-9 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

In considering possible future civil reactor systems it is important to be able to predict the fuel endurance and its dependence upon design parameters. Such a prediction model should ideally be formulated at an early stage in order that its validity can be tested, that essential data for its effective use are identified and collected, and that it may be used to coordinate and rationalize irradiation experiments which may otherwise be liable to misinterpretation. The model described was developed to cover the first two requirements for the case of triplex coated particle fuel for helium-cooled reactor systems. At present data are inadequate to give firm predictions, and the model has been extended to include a single empirical parameter, covering most of the uncertainties, which may be used at this stage for design optimization and for the third requirement. The simple model allows emphasis on the physical mechanisms and uncertainties, and those that have arisen through studying this model are discussed in some detail.

The simplicity of the single empirical parameter allows rapid correlation of experimental results and early design modifications. The speed and power of the method are illustrated by considering the case of an alternative coated particle where one of the high density pyrolytic carbon layers is replaced by an alternative material. (auth)

Plastics and Other Materials

Refer also to abstracts 11759, 11976, 12579, and 13394.

12805 (ITEF–828) DEFECTS IN GLASS FROM FISSION FRAGMENTS AND THEIR LIQUIDATION KINETICS DURING THERMAL ANNEALING. Gorshkov, V. K. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 34p. (In Russian). Dep. NTIS (U. S. Sales Only).

Fission fragments formed craters on glass surfaces when the irradiated glass was etched in hydrofluoric acid. A relative size of craters proportionate to quantity of defects produced by fragments. The types of defects and kinetics of coalescence were established by study of crater diameter changes in relation to the temperature and the annealing time between irradiation and etching of the glass. The activation energy of defects mobility increases due to decrease in number of defects and depends on the annealing temperature. The defects formation and annealing mechanisms were examined on the basis of atoms elastic displacement owing to inclusion of defects in order to explain the results. It is concluded that the fission fragment produces in glass large concentrations of twin defects in the form of displaced atoms and vacancies concentrated in different regions of dislocations. (auth)

12806 SHAPED POLYMERIC SHIELD AGAINST NEUTRON AND GAMMA RADIATION. Vogel, Reinhard Ernst (to Fredrich Marxen). U. S. Patent 3,609,372. 28 Sep 1971. Filed 6 Sep 1968.

A polymeric material having a shielding effect against radiation is provided in the form of a shaped body which may be a plate, flexible sheet, or of any other desired shape, which body consists essentially of a synthetic plastic material including synthetic or natural rubber. The material contains an effective amount of at least one compound of a saturated fatty acid being solid at room temperature and having at least 9 carbon atoms with at least one metal selected from the group consisting of lead, bismuth, tungsten, zirconium, iron, tin, cadmium, lithium and barium. (Official Gazette)

12807 METHOD OF DETERMINING THE VALUE OF A MECHANICAL PROPERTY OR PROPERTIES OF A FIBRE. Marjoram, John Raymond (to Rolls-Royce Ltd.). British Patent 1,255,644. 1 Dec 1971. Filed 10 May 1968.

The method described has particular application to carboniferous fibers such as those formed from poly(acrylonitrile) or from a cellulose material. Fibers having crystallites in a preferred orientation are examined by x-ray diffraction using first and second detectors, the former being positioned so as to receive substantially a maximum indication of x radiation, and the latter so as to receive an indication where magnitude with respect to the indication from the former is predetermined. The value of the property (e.g., Young's modulus) being examined is then determined from the relative positions of the first and second detectors. Determinations are preferably made continuously along a length of the fiber to obtain an average value. The required apparatus is described, together with its mode of operation. (UK)

12808 CONCRETE AS BASIC MATERIAL FOR SHIELDS AGAINST IONIZING RADIATION. Ablewicz, Z.; Jozwik, B. (Projektow Techniki Jadrowej Proatom, Warsaw). Inz. Budownictwo; 27: 385-91(1970). (In Polish).

Described are sources of radiation, the influence of radiation on matter, kinds of shields, and material requirements. The shielding properties of various types of concrete are discussed. The necessity for unifying the technology of processing concrete for shields is pointed out. This requires the continuation of detailed research in the field of materials, technology, and concrete properties. (auth) (NSA of Poland)

12809 TERNARY SYSTEMS CONTAINING UCl_3 AND UCl_4 WITH THE CHLORIDES OF Na, K, OR Ca. Desyatnik, V. N.; Mel'nikov, Yu. T.; Raspopin, S. P.; Sushko, V. I. At. Energ. (USSR); 31: No. 6, 631-3(Dec 1971). (In Russian).

Melting point diagrams were constructed for the systems UCl_3–UCl_4–NaCl, UCl_3–UCl_4–KCl, and UCl_3–UCl_4–$CaCl_2$ using the differential thermal method. In the NaCl system eutectic and peritectic points were observed at 338 and 432°C, respectively. Three eutectic points at 522, 518, and 314°C were found in the diagram with KCl. In the $CaCl_2$ diagram only one eutectic (455°C) was found. (K.S.W.)

12810 STEREOISOMERIC COMPLEX AS LIGHT-TRANSMISSIVE MEANS OF IMPROVED RESISTANCE TO RADIATION DAMAGE. Gardner, Donald G.; Henry, George A. (to United States Atomic Energy Commission). U. S. Patent 3,607,988. 21 Sep 1971. Filed 1 Oct 1968.

A description is presented of a solid polymer composition mixture of 60 to 75 percent syndiotactic polymer with 25 to 40 percent isotactic polymer produced from certain monomers of the type having an asymmetric structure and including polar substituent groups, and having improved resistance to radiation damage. (Official Gazette)

12811 SIMULATION OF HETEROGENEOUS GAS EQUILIBRIA. I. METAL–HALOGEN SYSTEMS WITH EXAMPLES FOR THE TUNGSTEN–HALOGEN SYSTEMS. Gottschalk, Guenter; Neumann, G. M. (OSRAM-Studiengesellschaft, Munich). Z. Metallk.; 62: No. 12, 910-15(Dec 1971). (In German).

The theoretical foundations of the general and computer-oriented calculation of the states of equilibrium in the gaseous phase are demonstrated on simple heterogeneous metal-halogen systems. Especially for the $W-X_2$ systems results of the simulation based on models developed, which are interesting for practical use, are briefly outlined and elucidated by graphs and tables. (auth)

12812 DIFFUSION AND TRAPPING OF RARE GAS XENON IN CALCIUM FLUORIDE SINGLE CRYSTALS. Ong, A. Sy; Elleman, T. S. (North Carolina State Univ., Raleigh). Contract AT(40-1)-3508. J. Nucl. Mater.; 42: No. 2, 191-202 (Feb 1972).

Xenon-133 was injected into CaF_2 single-crystals through fission recoil, and rare gas diffusion measurements were carried out over the temperature range 750 to 1000°C for three gas concentrations. Classical diffusion results were obtained at low gas concentrations with the values of D given by: $D = D_0 \exp(-\Delta H/kT)$, $D_0 = 9.50 \times 10^6$ cm^2/sec, $\Delta H = 4.42 \pm 0.12$ eV. Trapping of ^{133}Xe by radioinduced defects was observed at the two higher gas concentrations and the trap concentrations were found to be dose and temperature dependent. Trap concentrations and gas retention times in the traps were calculated using a trapping model which assumed a uniform trap distribution and finite residence times for the gas in the traps. The trap concentrations were found to be too high for trapping to occur through gas-atom clustering; the traps appear to be radiation-generated defect clusters. The diffusion results are more consistent with a diffusion model based on transport of gas atoms in mobile defect clusters than through other diffusion processes. (auth)

12813 MORPHOLOGY AND SYMMETRY OF U_3S_5 CRYSTALS. Morozov, S. P.; Zhuldybina, G. M.; Eliseev, A. A.; Slovyanskikh, V. K.; Ellert, G. V. (Moscow Inst. of Fine Chemical Tech.). Zh. Neorg. Khim.; 16: No. 7, 2018-20(Jul 1971). (In Russian).

The morphological features and symmetry of monocrystals of U_3S_5 prepared by a gas transport reaction were studied. Using Br_2 or I_2 as the carrier, and varying the temperatures of the hot and cold zones produced polyhedra which were combinations of pinacoid, rhombic prism, and rhombic bipyramid were found. (K.S.W.)

12814 SYNTHETICS USED IN NUCLEAR ENERGY TECHNOLOGY. Wilski, H. (Farbwerke Hoechst AG, Frankfurt am Main). Kunststoffe; 60: No. 10, 716-18(1970). (In German).

A survey of uses of synthetics in nuclear technology is given, e.g., as moderator material, for fabrication of shielding and rabbits, for laboratory installations which can thus be easily decontaminated, and for dosimeters. Problems of radioresistance are discussed. (INIS)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 13574.

12815 PHYSICS 1971: A SURVEY OF PROGRESS. Thouless, D. J. Phys. Bull. (London); 22: 711-19(Dec 1971).

Brief summaries are given of progress in 1971 in the following fields: theoretical advances; the complex nucleus; high energies; low temperatures; low energy electron diffraction, Auger and epitaxy; bonds and bands in solids; making magnetic materials; new techniques for atomic physics; excitement in glass; achievements of new astronomy; satellites, moon and beyond; towards controlled fusion; promise from lasers. (68 references). (UK)

Cosmic Ray Exposure Ages

12816 Hg II LINE IN HR 465. Cowley, Charles R.; Aller, Margo F. (Univ. of Michigan, Ann Arbor). Astrophys. Lett.; 9: No. 4, 159-60(Nov-Dec 1971).

The shape of the Hg II line λ3984 in HR 465 changed markedly from 1961 to 1969. The interpretation of this observation is not unique, but an explanation in terms of surface nuclear activity is a distinct possibility. (auth)

12817 URANIUM CONTENT AND RADIOGENIC AGES OF HYPERSTHENE, BRONZITE, AMPHOTERITE, AND CARBONACEOUS CHONDRITES. Fisher, David E. (Univ. of Miami, Fla.). Geochim. Cosmochim. Acta; 36: No. 1, 15-33(Jan 1972).

Uranium was measured by fission-track analysis in 115 samples of hypersthene, bronzite, amphoterite, and carbonaceous chondrites. On a weight basis the average values for the C1 carbonaceous and bronzite chondrites are similar to the "classic" value of 11 ppb, but the hypersthenes and amphoterites are ~50% higher. Each class shows a well-determined peak in the U abundance distribution, allowing the calculation of radiogenic ages and comparison with other elements of interest. (auth)

12818 FOSSIL TRACKS IN THE METEORITE ANGRA DOS REIS: A PREDOMINANTLY FISSION ORIGIN. Bhandari, N. (Tata Inst. of Fundamental Research, Bombay). Nature (London); 234: No. 5331, 540-3(31 Dec 1971).

The meteorite Angra dos Reis is an augite achondrite, known to have a high U concentration and for which the concentrations of rare gases, both fissiogenic and cosmogenic, are known; it is also rich in pyroxene. Photomicrographs of etched fossil surface tracks are shown, together with those of track-in-track and track-in-cleavage types, and also those of neutron induced tracks. The observed length distribution of fossil tracks in this meteorite was found to be unique and unlike any other meteorite or lunar material inasmuch that tracks shorter than 15 μm, due to cosmic rays, were rare. It was concluded that $\leq 10^{-3}$ of the fossil tracks were due to cosmic-ray nuclei, and that the remainder must be attributed to U and transuranic fission. The neutron-induced track density in the annealed material indicated a mean U concentration of 220 ppB, and this would lead to only 6.2×10^5 tracks/cm^{-2} due to spontaneous fission of ^{238}U in 4.6 billion years; hence the majority of the fission tracks must have been due to spontaneous fission of both ^{244}Pu and ^{238}U, with an estimated mean ratio of ∝19. An important finding is that, over the lifetime of the meteorite as a solid body, the stored tracks have not been annealed to a measurable extent, as opposed to findings for terrestrial apatites of 0.4 to 1.2 billion years age. Some of the tracks appear to have been due to spontaneous fission of super-heavy transuranic elements. It is stated that the observation of a cosmic-ray track density of $\leq 10^4$/cm^2 is very interesting, considering that the cosmic-ray exposure age is 68 my. (UK)

Stars

Refer also to abstracts 13109, 13224, and 13798.

12819 PULSATING STARS IN GENERAL RELATIVITY. Cohen, Jeffrey M. (Inst. for Advanced Study, Princeton, N. J.). Int. J. Theor. Phys.; 3: No. 4, 267-81(Aug 1970).

The equation governing radial pulsations of fully relativistic stars is derived and expressed in terms of quantities that are continuous even across density discontinuities that occur, e.g., in zero-temperature stellar models that undergo electron capture. When expressed in terms of these quantities, the pulsation equation can be integrated through density discontinuities without any special treatment of these points being necessary. Expressions for the adiabatic index and pulsation energy are derived in a simple way. (auth)

12820 X-RAY SOURCES AND FINAL STAGES OF STELLAR EVOLUTION. Weidemann, V. (Univ., Kiel). Astrophys. Lett.; 9: No. 4, 155-7(Nov-Dec 1971).

Stellar statistical arguments favor the existence of stars that neither become white dwarfs nor undergo supernova explosion and can be identified with x-ray sources of the Cyg X-1 type. It is suggested that not the parent mass but the angular momentum history, as described by the rotation parameter GM^2/Jc, decides whether a star at the end of its nuclear evolution approaches a spherical symmetrical situation with supernova explosion and pulsar formation, or stores its gravitational energy in the form of rotating disks. (auth)

12821 VIBRATIONAL STABILITY OF DA WHITE DWARFS. Vauclair, G. (Observatoire Meudon, France). Astrophys. Lett.; 9: No. 4, 161-4(Nov-Dec 1971).

The vibrational stability of twenty-five models of DA white dwarfs was studied. Evidence is shown that the efficiency of κ mechanism can drive the radial pulsations on both the fundamental and the first harmonic modes. The influence of an external shell burning is discussed. The instability region is delimited in the H−R diagram. (auth)

12822 INFLUENCE OF A SLOWLY VARYING AXIAL MAGNETIC FIELD ON THE STABILITY OF A GRAVITATING CYLINDER. Bhat, P. K. (Indian Inst. of Science, Bangalore). Indian J. Phys.; 44: No. 6, 356-66(Jun 1970).

The effect of a slowly varying axial magnetic field on the stability of a gravitating cylinder was considered. In the case of axisymmetric disturbances it was found that whenever the system is unstable the effect of this small inhomogeneity of the field is to add to the instability of the system. Further, an increase in the magnitude of the magnetic field decreases the wave number thereby stabilizing the long wavelength disturbances. In the case of two-dimensional disturbances it was found that the stability of the system is not influenced by the functional form f(r), r being the radial coordinate, of the axial magnetic field within the cylinder, in the absence of surface currents. (auth)

12823 FURTHER STUDIES OF VARIABLE STARS OF THE LARGE MAGELLANIC CLOUD. Wright, Frances W. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.); Hodge, Paul W. Astron. J.; 76: No. 10, 1003-16(Dec 1971).

The completion of a study of the variable stars in the section of the Large Magellanic Cloud centered at $\alpha = 5h12m$, $\delta = -67.5°$ is reported. Measures in two colors, B and V, were obtained on a series of 80 ADH Schmidt plates, and measures in B were made on approximately 400 Harvard Bruce plates for each variable star. Fifteen of the variables were found to be classical Cepheids with periods from 1.97 to 10.5 days. All but two fit well on the period–luminosity relationship previously published; the two anomalous Cepheids are apparently highly reddened. The ratio of general-to-selective extinction was found to be possibly different from that in the solar neighborhood. (auth)

12824 PHOTOMETRY OF WY SGE (NOVA SAGITTAE 1783). Warner, Brian (Univ. of Texas, Austin). Publ. Astron. Soc. Pac.; 83: No. 496, 817-18(Dec 1971).

Weaver's (1951) identification of WY Sge as Nova Sagittae 1783 was confirmed by detecting rapid variations of brightness. (W.D.M.)

12825 DYNAMIC EVOLUTION OF RICH GALACTIC STAR CLUSTERS. I. Prata, Stephen W. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astron. J.; 76: No. 10, 1017-28(Dec 1971).

Results are presented of a theoretical study of the dynamic evolution of rich galactic star clusters. The model uses a distribution of stellar masses and takes into account tidal limitation, star loss, gas loss, and tidal shocks. The evolution of the mass function depends primarily on the mass function itself (including scaling) and only secondarily on the cluster structure. M67's original mass function was strongly deficient in low-mass stars. M67's continued existence is the result of a fortunate combination of initial conditions. Effects of a mass mixture on star

loss are discussed. General comments on cluster evolution are made. (auth)

12826 DYNAMIC EVOLUTION OF RICH GALACTIC STAR CLUSTERS. II. Prata, Stephen W. (California Inst. of California, Pasadena. Carnegie Institution of Washington, D. C. Astron. J.; 76: No. 10, 1029-40(Dec 1971).

A method is presented for calculating star cluster dynamic evolution using a series of equilibrium models of the King type. Effects of star loss, gas loss, tidal shocks, tidal limitation, and of a mass function are included. Existing theories for the first three effects are carried another step further. (auth)

12827 uvby AND H β OBSERVATIONS OF B-TYPE STARS IN THE SCORPIO–CENTAURUS ASSOCIATION. Glaspey, John W. (Univ. of Arizona, Tucson). Astron. J.; 76: No. 10, 1041-7(Dec 1971).

Photoelectric uvby and Hβ photometric data for a large number of B-type stars in the Scorpio–Centaurus association were analyzed to show that subgroups with different ages exist within the association. The Upper Scorpius subgroup is significantly younger than the Upper Centaurus subgroup. The situation for the Lower Centaurus subgroup is ambiguous, but its age is similar to the other two groups' ages. The large number of peculiar B-type stars detected spectroscopically by Garrison (1967) appear also to be distinguishable from normal B-type stars by using the m_1 index of the uvby photometric system. The mean m_1 index of the mid-B-type stars in Upper Scorpius is approximately 0.03 mag larger than the mean index of the corresponding stars in Upper Centaurus. A similar photometric effect was pointed out by Cameron (1967) for Bp and Ap stars as compared to normal B- and A-type stars. Attempts to explain this difference in the m_1 indices from the following causes have all proven to be unsuccessful: (i) systematic errors in the photometric data, (ii) incorrectly applied interstellar reddening corrections, (iii) m_1 deviations created by different mean rotational velocities in the two regions, (iv) systematic differences in the Hδ line strengths related to different evolutionary stages for the regions, and (v) m_1 differences created by a larger frequency of undetected binary stars in one of the regions. (auth)

12828 FOUR-COLOR AND Hβ PHOTOMETRY FOR OPEN CLUSTERS. VII. NGC 6231 AND THE I SCO ASSOCIATION. Crawford, D. L. (Kitt Peak National Observatory, Tucson, Ariz. Cerro Tololo Inter-American Observatory, La Serena, Chile); Barnes, J. V.; Hill, G.; Perry, C. L. Astron. J.; 76: No. 10, 1048-57(Dec 1971).

Photoelectric photometry was obtained at the Cerro Tololo Inter-American Observatory for 154 stars in the neighborhood of the open cluster NGC 6231. Analysis of the data lead to a calculated distance modulus for the cluster and the association of $V_0 - M_V = 11.5$m, determined from data for 110 probable member stars. An average interstellar absorption of 1.4m was derived, mostly caused by foreground absorbing matter. Several of the stars were brighter than $M_V = -1.0$m. (auth)

12829 FOUR-COLOR, H β, AND UBV PHOTOMETRY FOR BRIGHT B-TYPE STARS IN THE NORTHERN HEMISPHERE. Crawford, D. L.; Barnes, J. V.; Golson, J. C. (Kitt Peak National Observatory, Tucson, Ariz.). Astron. J.; 76: No. 10, 1058-71 (Dec 1971).

Photoelectric photometry is presented for 491 B-type stars north of Dec. −10° and with $m_V \leq 6.5$m. (auth)

12830 UBV PHOTOMETRY OF EARLY-TYPE STARS IN TWO REGIONS AT HIGH GALACTIC LATITUDES. Drilling, John S. (Louisiana State Univ. Observatory, Baton Rouge). Astron. J.; 76: No. 10, 1072-8(Dec 1971).

Magnitudes and color indices on the UBV system were determined for 125 stars near l = 0°, b = −45° and for 85 stars near l = 180°, b = −45° which are of spectral class A7 or earlier and brighter than V = 14.6 according to the finding lists of Philip and Drilling. The colors of the stars brighter than V = 12 indicated that they were primarily normal B- and A-type stars and metallic-line stars, with little or no reddening at l = 0°, b = −45° and reddened by up to $E_{B-V} = 0.08$ at l = 180°, b = −45°. The run of space density with z was determined for stars of spectral classes A2–A7 in the two regions and is shown to be similar to that of A2–A7 stars in the vicinity of the North Galactic Pole. A number of the fainter stars in both regions which had intrinsic B–V colors of less than 0.14 were found to have the ultraviolet deficiencies characteristic of blue horizontal-branch stars in globular clusters. (auth)

12831 DISTANCES OF TWO FAINT OB STAR GROUPS IN MONOCEROS. Graham, J. A. (Cerro Tololo Inter-American Observatory, La Serena, Chile). Astron. J.; 76: No. 10, 1079-81(Dec 1971).

UBV and Hβ photometry are presented for 11 stars in a field in Monoceros (l = 218°, b = −0.5°). Radial velocities were measured for nine of the stars. The data suggest that there are two groups of OB stars in this direction, one at a distance of 2.4 kpc and one less well established at 3.8 kpc. (auth)

12832 FINDING LIST OF FAINT BLUE STARS IN THE ANTICENTER REGION OF THE GALAXY. Rubin, Vera C. (Carnegie Institution of Washington, D. C.); Losee, John M. Astron. J.; 76: No. 10, 1099-1101(Dec 1971).

Finding charts, coordinates, color, and magnitude estimates are given for 63 faint blue stars in the anticenter region of the Galaxy. The stars were detected on a three-color plate taken with the Palomar 48-inch Schmidt telescope, following the method developed by Haro and Luyten. It is likely that some of these stars are OB main-sequence stars at great distances from the center of the Galaxy. (auth)

12833 COLOR EXCESS OF POLARIS. Schmidt, Edward G. (Univ. of Arizona, Tucson. Kitt Peak National Observatory, Tucson, Ariz.). Astron. J.; 76: No. 10, 1102-4(Dec 1971).

The color excess of Polaris was found from measurements of the Hα profile and the G-band strength. The Hα profile indicated that this star is unreddened while the G band indicated a color excess of $E_{B-V} = 0.07$m. Comparison with another Cepheid of similar period, SZ Tau, indicated that the G band in Polaris is slightly weak for its temperature. It was therefore concluded that Polaris is unreddened and that its amplitude is reasonably consistent with its location in the instability strip. (auth)

12834 LOW-LUMINOSITY BOUNDARY OF THE β CEPHEI INSTABILITY STRIP. Percy, John R. (David Dunlap Observatory, Richmond Hill, Ont.). Astron. J.; 76: No. 10, 1105-7(Dec 1971).

Several suspected β Cephei stars, less luminous than known β Cephei stars, were tested for short-period light variations and were found to be constant, the upper limit to their variations being between 0.005 to 0.010 mag. The β Cephei instability strip appears to terminate at its low-luminosity end near $M_V = -3.0$. (auth)

12835 DISTRIBUTION OF B8–A3 STARS NEAR THE GALACTIC PLANE. I. GALACTIC LONGITUDES 50 TO 150°. McCuskey, S. W.; Houk, Nancy (Case Western Reserve Univ., Cleveland). Astron. J.; 76: No. 10, 1117-28(Dec 1971).

Counts of B8–A3 stars to a limiting magnitude V = 13 along the galactic plane from l = 50 to 150° and, in general, between b = −5° and +5° yielded: (i) contour maps showing the surface distribution, and indicating several high-density areas; (ii) approximate space densities (corrected for interstellar absorption) to a distance of 1 kpc from the Sun. There was some indication that the A-star population in the local spiral feature tends to be concentrated toward the galactic center side of that feature. The A-star population in the interarm region (50° < l < 70°) at 250 and 500 pc from the Sun was less than half that in the nearer parts of the local spiral feature in the range 95° < l < 150°. The detailed results of the survey are displayed in histogram form. (auth)

12836 PARALLAX AND MASS RATIO OF ETA CASSIOPEIAE. van de Kamp, Peter; Worth, Michael D. (Swarthmore Coll., Pa.). Astron. J.; 76: No. 10, 1129-30(Dec 1971).

Measures on 881 plates with 3234 exposures, taken on 251 nights over the interval 1912 to 1970, with a total weight of 652, give a value of +0.162 ± 0.002 (p.e.) for the relative parallax and a value of 4.57 ± 0.06 for the semi-axis major of the orbit of the primary component. The adopted value of 0.170 ± 0.002 for the absolute parallax yields masses of $0.93_\odot$ and $0.59_\odot$ for the primary and secondary components, respectively. (auth)

12837 LUNAR OCCULTATIONS OF TWO MULTIPLE SYSTEMS. Beavers, W. I.; Eitter, J. J. (Iowa State Univ., Ames). Astron. J.; 76: No. 10, 1131-2(Dec 1971).

The photoelectric measurement of the lunar occultation of BD + 27° 943 reveals that the object is a triple system. Similar simultaneous two-color measurements of the known binary BD + 18° 2057 provide a measurement of projected separation and magnitude difference. (auth)

12838 SPECTRA AND COLORS OF TWO BLUE HORIZONTAL BRANCH STARS IN OMEGA CENTAURI. Rodgers, A. W. (Australian National Univ., Canberra). Astrophys. J.; 171: No. 2, 257-8(15 Jan 1972).

The spectra of two blue horizontal-branch stars in ω Cen are discussed and effective temperatures and gravities derived. They

are shown to have significantly weak helium lines in their spectra. (auth)

12839 IC 4665, A CLUSTER OF BINARIES. Abt, Helmut A.; Bolton, C. T.; Levy, Saul G. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 171: No. 2, 259-66(15 Jan 1972).

Radial velocities of the 19 brightest stars in this open cluster show that all but one are spectroscopic binaries. Orbital elements are derived for 13 systems, and one additional one is double-lined. It is suggested that the low mean rotational velocity for stars in this cluster is due to its reduction by tidal interactions in binary systems, although in most of the systems with periods greater than 6 days the rotational motion has not yet attained synchronization with the orbital motion. (auth)

12840 CIRCUMSTELLAR SHELLS IN THE YOUNG CLUSTER NGC 2264. II. INFRARED AND FURTHER OPTICAL OBSERVATIONS. Strom, Stephen E. (State Univ. of New York, Stony Brook. Smithsonian Astrophysical Observatory, Cambridge, Mass.); Strom, Karen M.; Brooke, A. L.; Bregman, Joel; Yost, Jonathan. Astrophys. J.; 171: No. 2, 267-78(15 Jan 1972).

Flux measurements at 1.6, 2.2, and 3.4 μ for 42 stars in the young cluster NGC 2264 suggest that a significant number of these stars are surrounded by circumstellar material which produces observable infrared excesses. Hydrogen line profiles were used to estimate surface gravities and thereby to predict visual luminosities for a number of pre-main-sequence A stars. Those stars which appear faintest as compared with their predicted luminosities all had infrared excesses. This comparison provided strong evidence in favor of circumstellar dust shells which have optical depths on the order of unity at visual wavelengths. These shells were found to have a very high ratio of total to selective absorption, which suggests a fairly high percentage of large particles. In general, the dust shells of lowest temperature were found to surround the stars of latest spectral type. In addition to the observed infrared excesses, infrared deficiences were observed for a number of stars. A tentative explanation for these deficiencies was sought in terms of unusual circumstellar or circumcluster extinction in which the color-excess ratio E_{V-K}/E_{B-V} is unusually small. Again, this observation appeared to demand the presence of a significant number of large particles. (auth)

12841 OBSERVATIONAL EVIDENCE OF COLLISIONAL EXCITATION IN TWO DIFFUSE NEBULAE. Cromwell, Richard H. (Optical Sciences Center, Tucson, Ariz. Steward Observatory, Tucson, Ariz.); Lynds, Beverly T. Astrophys. J.; 171: No. 2, 279-84(15 Jan 1972).

Two reflection nebulae having unusual emission filaments near their edges were found to have very steep Balmer decrements of the first four Balmer lines. Line ratios of the emission filaments agreed well with the theoretical ratios predicted by Parker on the theory of collisional excitation and ionization. (auth)

12842 COMPARISON OF THE LUMINOSITIES OF PERSEUS-ARM STARS IN THE Hγ AND MK SYSTEMS. Crampton, David (Dominion Astrophysical Observatory, Victoria, British Columbia). Astrophys. J.; 171: No. 2, 285-91(15 Jan 1972).

Stars ascribed to the Perseus arm on the basis of their interstellar lines were used to compare absolute magnitudes determined from MK spectral types with those derived from Hγ equivalent widths. For the majority of these stars (B0–A3 supergiants) there were no significant differences in the luminosities determined from the two methods and random errors appeared to be of comparable magnitude. The random errors were considerably reduced (to about 0.3 mag) by taking means of the MK and Hγ absolute magnitudes, especially for stars which are variable in velocity. (auth)

12843 ULTRAVIOLET PHOTOMETRY FROM THE ORBITING ASTRONOMICAL OBSERVATORY. II. INTERSTELLAR EXTINCTION. Bless, R. C.; Savage, Blair D. (Univ. of Wisconsin, Madison). Astrophys. J.; 171: No. 2, 293-308(15 Jan 1972).

Interstellar extinction curves over the region λλ3600 to 1100 for 17 stars are presented. The observations were made by the two Wisconsin spectrometers on board the Orbiting Astronomical Observatory 2, with spectral resolutions of 10 and 20 Å. The extinction curves generally show a pronounced maximum at λ2175 ± 25, a broad minimum in the region λλ1800 to 1350, and finally a rapid rise to the far-ultraviolet. Large extinction variations from star to star were found, especially in the far-ultraviolet; however, with only two possible exceptions in this sample, the wavelength at the maximum of the extinction bump was essentially constant. These data were combined with visual and infrared observations to display the extinction behavior over a range in wavelength of about a factor of 20. The observations appear to require a multicomponent model of the interstellar dust. (auth)

12844 SEMICONVECTION IN THE CORE-HELIUM-BURNING PHASE OF STELLAR EVOLUTION. Robertson, J. W.; Faulkner, D. J. (Australian National Univ., Canberra). Astrophys. J.; 171: No. 2, 309-15(15 Jan 1972).

A treatment of the expansion by convective overshooting of the helium-burning convective cores in stars over a wide mass range is described. A semiconvective zone forms outside the core, and this zone was followed through its evolution. In some circumstances there is a fully convective region embedded in this zone. To illustrate the semiconvection treatment, the core-helium-burning phases of 5 $M_\odot$ and 1.5 $M_\odot$, Population I stars were computed to near exhaustion of helium in the core. (auth)

12845 EQUILIBRIUM, PULSATIONAL, AND SECULAR STABILITY PROPERTIES OF THE LOWER CARBON-BURNING MAIN SEQUENCE. Mariska, John T. (Univ. of Colorado, Boulder); Hansen, Carl J. Astrophys. J.; 171: No. 2, 317-21(15 Jan 1972).

Results are presented for stellar models composed of equal amounts of ^{12}C and ^{16}O in complete equilibrium within the mass range $0.82 \leq M/M_\odot \leq 2.31$. The character of the static models is analogous to the lower helium main sequence in that they are double-valued with respect to mass whereas the central density is monotonic along the sequence. All the models are pulsationally unstable, but only one, near the minimum mass, is secularly unstable. (auth)

12846 ROTATION AND LITHIUM ABUNDANCE IN SOLAR-TYPE STARS. Dicke, R. H. (Princeton Univ., N. J. Inst. for Advanced Study, Princeton, N. J.). Astrophys. J.; 171: No. 2, 331-62(15 Jan 1972).

The mild thermally driven turbulence associated with the Goldreich–Schubert–Fricke instability induces diffusive transport of angular momentum and lithium. The same diffusivity controls both processes. The slowing of rotation observed in young solar-type stars and the rate of loss of angular momentum from the Sun to the solar-wind can be quantitatively related to the loss of lithium (and of beryllium if the instability extends deep enough). It is concluded that the instability cannot extend much deeper than the onset of fast burning of ^7Li. By contrast, the assumption that a mild thermally driven turbulence is terminated at the boundary of a rapidly rotating core, perhaps by a jump in mean molecular weight $\Delta\mu \sim 10^{-3}$, is used to give a quantitative account of the depletion of ^7Li in the Sun and solar-type stars. Lithium-6 should be strongly depleted, but ^9Be not at all. The requirements that for the Sun, both the rotation and the ^7Li abundance, agree with the observations and give for each possible choice of core radius a value for the solar-wind torque and a lower bound for the angular velocity of the core. (auth)

12847 STRENGTH OF THE O I lambda7774 LINE IN THE BRIGHTEST STARS IN THE MAGELLANIC CLOUDS. Osmer, Patrick S. Astrophys. J.; 171: No. 2, 393-6(15 Jan 1972).

Image-tube spectra indicate that the strength of the O I λ7774 line in the F-type supergiants in the Magellanic Clouds is consistent with the relation between line strength and luminosity shown by their galactic counterparts. However, the A-type supergiants in the Clouds have a weaker oxygen line than expected. (auth)

12848 GLOBULAR-CLUSTER STARS: RESULTS OF THEORETICAL EVOLUTION AND PULSATION STUDIES COMPARED WITH THE OBSERVATIONS. Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Publ. Astron. Soc. Pac.; 83: No. 496, 697-740(Dec 1971).

The nature of the relevant observational material is summarized and the results of evolution theory are described along with the results of pulsation theory. These results are compared with observations. (W.D.M.)

12849 LUMINOSITIES AND MOTIONS OF THE F-TYPE STARS. I. LUMINOSITY AND METAL ABUNDANCE INDICES FOR DISK-POPULATION STARS. Eggen, O. J. (Australian National Univ., Canberra). Publ. Astron. Soc. Pac.; 83: No. 496, 741-61(Dec 1971).

Intermediate (uvbyβ) and broad (UBV) band colors are not available for over 1000 bright, F-Type stars for which accurate apparent motions have also been determined. The luminosity ($\Delta[c_1]$) and metal abundance ($\delta(U-B)$, and $\Delta[m_1]$) parameters were examined for Hyades group stars, other young disk stars including the Sirius group, and old disk stars, including the Wolf 630 and ζ Herculis group members. A procedure was developed for computing luminosities from the intermediate-band indices for both young and old disk population objects. The comparison between photo-

metric parallaxes and the group or trigonometric values indicated errors of not more than about 0.3m for the photometric luminosities. Ultrashort-period Cepheids in the young disk population and a comparison between the metal abundance parameters $\Delta[m_1]$ and δ (U − B) are also briefly discussed. (auth)

12850 NATURE OF THE BLUE STRAGGLERS IN THE OLD DISK POPULATION. Eggen, Olin J. (Australian National Univ., Canberra). Publ. Astron. Soc. Pac.; 83: No. 496, 762-7(Dec 1971).

It is suggested, on the basis of four new variables, that there is more evidence for the presence of ultrashort-period Cepheids than of close binaries among the blue stragglers of the old-disk population and that the hypothesis which links the existence of stragglers with the interaction of the components of close binaries may need re-examination. The possibility that one of the newly discovered variables, HD 100366, and the known, large-amplitude ultrashort-period SX Phoenicis are blue stragglers in the halo population is discussed. (auth)

12851 BLUE STARS ABOVE THE TURN-OFF IN M67: HORIZONTAL BRANCH OR BLUE STRAGGLERS. Strom, Stephen E. (State Univ. of New York, Stony Brook. Smithsonian Astrophysical Observatory, Cambridge, Mass.); Strom, Karen M.; Bregman, Joel N. Publ. Astron. Soc. Pac.; 83: No. 496, 768-79(Dec 1971).

The nature of the pseudohorizontal branch in the galactic cluster M67 was investigated. A differential technique was used to determine the masses of these stars relative both to the turnoff-point stars and to the ZAMS. The pseudohorizontal-branch stars were found to have masses in the range $1.3 < M/M_{\odot} < 2.5$; a mass lower than or equal to the turnoff-point mass seems to be ruled out. This result suggests that these stars are analogs of the blue stragglers found in other galactic clusters rather than Population I analogs of Population II blue horizontal-branch stars. As by-products of this investigation, the zero-age main sequence was calibrated in terms of effective temperature and log g for the β-(b − y) and β-c_1 planes; a value of reddening of $E_{b-y} = 0.04$ or $E_{B-V} = 0.06$ was derived for M67 and the metal content of the M67 stars was estimated to be solar or slightly lower. (auth)

12852 INTERNAL PROBABLE ERRORS OF RADIAL-VELOCITY DETERMINATIONS. Fenimore, E. E.; McGrath, D. N.; Nachman, P. M.; O'Dell, C. R.; Sanner, F. C. (Yerkes Observatory, Williams Bay, Wis.). Publ. Astron. Soc. Pac.; 83: No. 496, 780-2(Dec 1971).

A general expression for internal probable errors of radial-velocity determinations is derived, utilizing an idealized absorption-line profile and a simplistic statistical approach. This method considers the role of dispersion, plate resolution, spectrum width, and intrinsic line width. Comparison with the published study of Abt and Smith indicates satisfactory agreement. Methods of optimizing results are then discussed. (auth)

12853 STARS OBSERVED PHOTOELECTRICALLY NEAR QUASARS AND RELATED OBJECTS. Penston, Margaret J. (Royal Greenwich Observatory, Hailsham, Eng.); Penston, M. V.; Sandage, Allan. Publ. Astron. Soc. Pac.; 83: No. 496, 783-99 (Dec 1971).

UBV photometry is listed for 59 stars near 18 quasars and two unidentified radio sources and for 54 stars near ten Seyfert and four N-Type galaxies. Some of the stars are suitable for use as secondary photoelectric standards. Many are faint enough so as to avoid large coincidence corrections for pulse counting with large telescopes. In some fields, the sequences are extensive enough to be used for calibration of photographic monitoring programs. Finding charts are given for all listed stars. (auth)

12854 OPEN CLUSTER NGC 6025. Feinstein, A. (Univ. Nacional, La Plata). Publ. Astron. Soc. Pac.; 83: No. 496, 800-4(Dec 1971).

Photoelectric UBV measures are presented for 78 stars in the open cluster NGC 6025. Distance and age estimates derived are 760 parsecs and 1×10^8 years. The brightest star, HD 143448, is a known emission star and it is very probably a member of the cluster. (auth)

12855 HR 6773: A POSSIBLE ECLIPSING BINARY. Hube, Douglas P. (Univ. of Alberta, Edmonton). Publ. Astron. Soc. Pac.; 83: No. 496, 805-6(Dec 1971).

It is suggested that the recently discovered variable star HR 6773 is an eclipsing binary system. The spectroscopic evidence in favor of this suggestion is presented. It is noted that the star is also a visual binary—a fact previously known, but incorrectly recorded. (auth)

12856 REVISED ORBIT FOR 4 URSAE MINORIS. Scarfe, C. D. (Victoria Univ., British Columbia). Publ. Astron. Soc. Pac.; 83: No. 496, 807-9(Dec 1971).

Radial velocities from 28 coudé spectrograms were used to redetermine the elements of this single-line K giant binary. (auth)

12857 SPECTROSCOPIC OBSERVATIONS OF THE EARLY DECLINE OF NOVA SERPENTIS 1970. Walborn, Nolan R. (Univ. of Toronto). Publ. Astron. Soc. Pac.; 83: No. 496, 813-16(Dec 1971).

Classification-dispersion spectrograms obtained on the night after maximum light and throughout the early decline of Nova Serpentis 1970 are illustrated. The behavior of the diffuse enhanced absorption system is particularly interesting. In addition, one spectrogram of Nova Aquilae 1970 is illustrated. (auth)

12858 STRANGE CASE OF V605 AQUILAE. van den Bergh, Sidney (Univ. of Toronto). Publ. Astron. Soc. Pac.; 83: No. 496, 819-21(Dec 1971).

A 200-inch plate shows that the peculiar slow nova V605 Aql occurred within a few seconds of arc of the center of planetary nebula 37 − 5°1. (auth)

12859 STAR CLUSTERING NEAR THE NGC 68-72 GROUP OF GALAXIES. Tifft, W. G.; Gregory, S. A. (Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac.; 83: No. 496, 810(Dec 1971).

A study of stars clustering near the NGC 68−72 group of galaxies indicates the clustering is apparently only a fluctuation in foreground star density. (auth)

12860 UBVRI PHOTOMETRY OF V642 ORIONIS. Bookmyer, Beverly B. (Univ. of Arizona, Tucson. Clemson Univ., S. C.). Publ. Astron. Soc. Pac.; 83: No. 496, 824-7(Dec 1971).

The eclipsing binary system V642 Orionis was observed photoelectrically with U, B, V, R and I filters on three consecutive nights in 1968. The observations, which define one quarter of the light cycle, reveal no light variation, and it is concluded that improved light elements are needed. (auth)

12861 REDDENING OF STARS IN THE DIRECTION OF RR LYRAE. McNamara, D. H.; Croft, S. K. (Brigham Young Univ., Provo, Utah). Publ. Astron. Soc. Pac.; 83: No. 496, 828-9(Dec 1971).

BV photoelectric observations of twelve field stars near RR Lyrae were combined with earlier (khg) photometry to derive the color excess in the direction of the variable. The observational data yield E(B − V) = 0.02m. (auth)

12862 LIGHT VARIATION OF HR 5329. Desikachary, K.; Parthasarathy, M.; Rao, N. Kameswara (Osmania Univ., Hyderabad, India). Publ. Astron. Soc. Pac.; 83: No. 496, 832-3(Dec 1971).

From the photoelectric observations of HR 5329 on four nights, a probable fundamental period of 0.07306d (13.6875 c/d) was derived and a beat period around 16 days is suggested. (auth)

12863 CURVE-OF-GROWTH ANALYSIS OF THE SPECTRUM OF PROCYON. Griffin, R. (Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 2, 139-52(1971).

The spectrum of Procyon (F5 IV−V) is investigated in the region λλ4000 to 7500 Å from spectrograms having reciprocal dispersions of 1- to 1.5-Å mm^{-1}. A differential curve-of-growth analysis with respect to the Sun confirms that most elements in the atmosphere of Procyon have abundances, relative to hydrogen, similar to those in the Sun, although heavy elements ($Z \gtrsim 50$) appear to be slightly deficient. Particular problems which arise in the curve-of-growth comparison of these two stars are discussed. (auth)

12864 CAUSE OF THE NOVA OUTBURST. II. EVOLUTION AT 1.00 $M_{\odot}$. Starrfield, Sumner (Yale Univ., New Haven). Mon. Notic. Roy. Astron. Soc.; 155: No. 2, 129-37(1971).

The recent investigation of thermonuclear runaways in the hydrogen-rich envelopes of helium-rich white dwarfs as an explanation for the nova outburst has been extended to a mass of 1.00 $M_{\odot}$. Two models are considered; one is constructed as a more evolved version of the other. Both models are more violent than the models of lower mass. They produced over 10^{46} erg from nuclear reactions, their peak temperatures were greater than $10^{8.6}$°K, and the maximum rate of energy generation surpassed 10^{14} erg^{-1} g^{-1} s^{-1}. In addition, the time scale of the last part of the evolution is much shorter at 1.00 $M_{\odot}$ than for the models at lower mass. The evolution is stopped when the radiation pressure becomes greater than the gas pressure in the last few minutes of the

evolution. At this time the outer radii are increasing by more than 1 km s^{-1}. (auth)

12865 AXISYMMETRIC MULTIPOLE MAGNETIC FIELDS IN POLYTROPIC STARS. Chiam, T. C.; Monaghan, J. J. (Monash Univ., Clayton, Australia). Mon. Notic. Roy. Astron. Soc.: 155: No. 2, 153-67(1971).

The structure of axisymmetric, multipole magnetic fields of the poloidal type in polytropic stars is studied. The magnetic field is defined in terms of a stream function Ψ patterned after the stream function for a current ring. The result is derived that the current involves an arbitrary function of Ψ. By choosing this arbitrary function to be linear in Ψ and involving two arbitrary constants, various families of solutions are obtained by a perturbation method. Fields similar to those recently found to fit the observations are found and the structure of the field determined. (auth)

12866 POSSIBLE IDENTIFICATION OF Nd II IN EMISSION IN ARCTURUS. Fosbury, R. A. E. Mon. Notic. Roy. Astron. Soc.; 155: No. 2, 7P-10P(1971).

A feature in the wing of the K-line in Arcturus is identified with an emission line of Nd II. The occurrence of this line is briefly discussed in terms of Canfield's analysis of solar rare-earth lines. (auth)

12867 DEPARTURES FROM LOCAL THERMODYNAMIC EQUILIBRIUM IN THE NEUTRAL-HELIUM LINES OF EARLY-TYPE STARS. Hearn, A. G. (Univ. of Queensland, Brisbane). Mon. Notic. Roy. Astron. Soc.; 155: No. 2, 3P-5P(1971).

Recent, apparently conflicting, theoretical papers are discussed together with recent observations. It appears that there is in fact agreement in general terms that, in B-type stars, some strong lines of neutral helium are affected by departures from local thermodynamic equilibrium which cause serious errors in the determination of the helium abundance, while in some other lines these effects are negligible. (auth)

12868 ROTATING STARS WITH VERY LARGE MAGNETIC FIELDS. Monaghan, J. J.; Robson, K. W. (Monash Univ., Clayton, Australia). Mon. Notic. Roy. Astron. Soc.; 155: No. 2, 231-47(1971).

Uniformly rotating main-sequence stars with strong dipole magnetic fields are examined using a perturbation method. The spherically symmetric part of the perturbing forces is taken into account essentially exactly, while the nonspherical terms are treated as a perturbation. The form of the internal magnetic field, the perturbations to the pressure, temperature, luminosity, and the surface are computed. With a strong magnetic field alone the total luminosity is reduced, the nonspherical contribution to the luminosity is positive at the pole and negative at the equator. The nonspherical contribution to the temperature is negative at the pole and positive at the equator. The surface of the star is doughnut shaped and lies within the surface of the star without a magnetic field. (auth)

12869 STELLAR COMPOSITIONS FROM NARROW-BAND PHOTOMETRY. II. SODIUM AND MANGANESE IN THE HYADES AND FIELD GIANTS. Williams, P. M. (Cambridge Observatories, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 2, 215-29(1971).

Using narrow-band indices observed with the Cambridge spectrophotometer and the techniques described previously (Williams, Mon Notic. Roy. Astron. Soc., 153: 171(1971)) the sodium abundances of about 160 and manganese abundances of about 120 G and K giants were determined. The rms external errors in [Na/H] and [Mn/H] were found to be 0.20 and 0.27 respectively. The compositions of a number of super-metal-rich stars are discussed. The sodium-richness, relative to iron, of ϵ Vir and the Hyades giants is confirmed, while the Hyades dwarfs appear to have normal sodium abundances. The manganese abundance anomalies, [Mn/Fe], do not correlate with [Fe/H]. The Ba II stars do not appear to be either sodium-rich or manganese-poor, as some authors have suggested. (auth)

12870 ROTATIONALLY EXTENDED STELLAR ENVELOPES. III. THE Be COMPONENT OF VV CEPHEI. Hutchings, J B.; Wright, K. O. (Dominion Astrophysical Observatory, Victoria, B. C.). Mon. Notic. Roy. Astron.; 155: No. 2, 203-14(1971).

A new orbit is derived from the system of VV Cephei from recent observations. Emission line profiles of Hα in the spectrum obtained during the 1956–58 eclipse are studied and the variation of width, height, equivalent width, and velocity distortion presented as a function of phase. Various simplified calculations of the velocity and equivalent width are made and their inadequacy shown. A program is described for computing the Hα profile at any orbital phase, and a model for the system and the Be envelope that gives the best fit to the observational quantities is derived. The Be envelope is large, rotating at the limit of stability in its inner layers and apparently accumulating matter from gas streaming in its outer parts. The central star is probably a main sequence O8 star. Finally, out-of-eclipse light variations of 0.1m or more are predicted for this system and 32 Cygni by mutual distortion effects. (auth)

12871 NOTE ON MODELS FOR THE ENVELOPES OF LONG-PERIOD VARIABLE STARS. Langer, G. E. Mon. Notic. Roy. Astron. Soc.; 155: No. 2, 199-202(1971).

Keeley (1970) made an extensive investigation of the envelopes of long-period variable stars; he constructed a grid of static envelope models and made a nonlinear analysis of their oscillations. This note presents a simple linear stability analysis of four similar envelope models. Several of the results are compared to the results of Keeley's calculations. (UK)

12872 CURVES OF GROWTH AND LINE PROFILES FOR NEUTRAL-HELIUM LINES IN EARLY-TYPE STARS. O'Mara, B. J.; Simpson, R. W. (Univ. of Queensland, Brisbane). Mem. Roy. Astron. Soc.; 75: 51-84(1971).

Curves of growth are presented for those He I lines considered most useful in a helium abundance analysis. Line profiles are also presented for the three strongest lines — 4471, 4026, and 4388 Å. The results are given for line-blanketed model atmospheres with θ_e in the range 0.176 to 0.4 and log g = 3.5 to 4.0. For the weak lines the curves are tabulated for the two values of microturbulent velocity — ξ = 5 and 10 km sec^{-1}. The value ξ = 5 km sec^{-1} is used for the strong lines. Electron scattering effects, the LTE assumption, and the profile of the line absorption coefficient are discussed in some detail. (auth)

12873 PLEIADES LOWER MAIN SEQUENCE. Jones, Burton F. (Univ. of California, Santa Cruz). Astrophys. J.; 171: No. 2, L57-60(15 Jan 1972).

It is shown that the faint members of the Pleiades fall almost entirely below the zero-age main sequence. The most likely explanation is that these stars are surrounded by circumstellar shells having predominantly gray extinction properties. (auth)

12874 GRAVITIES OF BLUE HORIZONTAL-BRANCH STARS. Philip, A. G. Davis (Dudley Observatory, Albany. State Univ. of New York, Albany). Astrophys. J.; 171: No. 2, L51-5(15 Jan 1972).

Four-color observations were obtained for blue horizontal-branch stars in the globular clusters M3, M4, M13, M55, and M92. Surface gravities computed for 35 stars of Populations I and II by means of photoelectric scans or high-dispersion spectra were used to calibrate δc_1 against δ log g. For bright stars, δ log g can be computed from the (δc_1, δ log g) relation with a probable error of ±0.18 in the log. The (log g, θ_e) relation for BHB stars in M4, M55, and M92 is similar to that found for NGC 6397 by Newell, Rodgers, and Searle. The BHB stars in M3 and M13 have log g's which are about 0.3 smaller than BHB stars in the other clusters studied. (auth)

12875 K-LINE PHOTOMETRY OF SOUTHERN A STARS. Henry, Richard C. (Johns Hopkins Univ., Washington, D. C. Naval Research Lab., Washington, D. C.); Hesser, James E. Astrophys. J., Suppl. Ser.; 23: No. 202, 421-51(Dec 1971).

Extension of the photoelectric measurements of the strength of the calcium K-line to 223 stars of predominantly southern or equatorial declinations and well distributed in right ascension has expanded the existent list to 369 field stars for which a k-index is available, including many more Am stars. All available k-index data for field stars are presented. Previous conclusions regarding attribution of variations in K-line strength at a specific temperature to differences in calcium abundance, and assessment of that abundance variation as being about a factor of 2, are supported. Interstellar reddening probably contributes little to the scatter. A systematic overabundance of calcium that was tentatively suggested earlier may be spurious. Am stars are shown to be even more heterogeneous in their K-line strengths than was shown previously, and the data suggest that the calcium anomaly in Am stars may be slightly moderated by evolution off the zero-age main sequence. A number of stars that probably exhibit spectral peculiarities are identified by means of K-line and intermediate-band photometry. (auth)

12876 K-LINE PHOTOMETRY OF STARS IN POPULATION I CLUSTERS. Hesser, James E. (Cerro Tololo Inter-American

Observatory, La Serena, Chile); Henry, Richard C. Astrophys. J., Suppl. Ser.; 23: No. 202, 453-76(Dec 1971).

Photoelectric photometry of the K-line of calcium was performed for the A stars of five open clusters (Hyades, Pleiades, IC 2391, IC 2602, and NGC 6475) and one association (Orion). For NGC 6475 (M7) the relation between k and $(b-y)_0$ is a unique one, implying that abundance variations of calcium (and, presumably, other metals as well) in the cluster are less than about ±25% star to star, and that the original interstellar cloud from which it formed was similarly homogeneous. The Hyades appear metal-rich in comparison with the other clusters, the remainder of which have calcium abundances similar to those of field stars. The Hyades are also found to exhibit less variation in calcium abundance than the field stars, but the relationship in k versus $b-y$ is not as tight as for NGC 6475. Uncertain individual reddening corrections are the most serious limitation for the interpretation of data for reddened clusters other than NGC 6475. A number of stars in these clusters appear to exhibit previously unsuspected spectral peculiarities, as revealed by K-line and uvby-Hβ photometry. In particular, the young cluster IC 2391 may contain more weakly metallic stars than heretofore recognized. Evidence supporting three constraints on the metallicity anomaly has emerged. (i) Metallicism does not appear as a discrete phenomenon in the (dk, $d[m_1]$) plane, and a relatively smooth transition between normal and metallic-line stars is suggested by the observations. (ii) Possible support for the suggestion that metallicism is moderated by mild evolution off the zero-age main sequence may be inferred from the data. (iii) Evidence is found for the existence of weak Am stars in clusters younger than the Hyades. (auth)

12877 345-MICRON GROUND-BASED OBSERVATIONS OF M17, M82, AND VENUS. Joyce, R. R.; Gezari, D. Y.; Simon, M. (State Univ. of New York, Stony Brook). Astrophys. J.; 171: No. 2, L67-9(15 Jan 1972).

Observations from the ground in the 345-μ atmospheric window show that the sources M17 and M82 have large infrared fluxes in this spectral region. (auth)

12878 FINE ANALYSIS OF THE AP STAR HD 168733. Little, Stephen James. Los Angeles, Univ. of California (1971). 190p. University Microfilms Order No. 72-1490.

Thesis.

HD 168733 is a moderately sharp-lined star located at $\alpha = 18h\ 16m$, and $\delta = -36°\ 43'$ (1900). Its spectrum is remarkable because of the simultaneous presence of three ionization stages of iron (Fe I, II, and III), and for the presence of lines of Cl II, Ti III, and Sr II. The UBV colors of this star and its energy distribution indicate a near-main sequence position for this peculiar star with an effective temperature of 15,000°K and a log g of 3.5. The equivalent widths of 1200 spectral lines of 16 elements were measured, and the intensity profiles of H_γ, H_δ, H_ϵ, and five helium lines were reduced. This information was used to make a fine analysis of the chemical abundances in HD 168733 with the aid of unblanketed model atmospheres. Overabundances of the iron-peak elements scandium, titanium, chromium, and iron were found to be respectively 7, 2000, 10, and 30 times the solar value, while manganese was no more than 10 times overabundant (upper limit). Carbon, nitrogen, chlorine, silicon, and strontium were enhanced by factors of 10, 10, 70, 6, and 1000, respectively, while magnesium was normal with respect to the solar value, and sulphur appeared to be depleted by a factor of 2. No oxygen lines were found in HD 168733, and oxygen must be normal or depleted. Helium appeared to be slightly depleted. In addition, five stars were analyzed with the aid of model atmospheres in an attempt to smooth the f-values of Warner (1967) for Ti II, Cr II, and Fe II. The quality of the resulting f-values was judged with the use of the spectrum of HD 168733 which contains many lines of Ti II, Cr II, and Fe II. The scatter of the individual Warner f-values was slightly reduced for all three ions, and several dozen f-values were corrected by amounts as great as 1.0 dex. (Diss. Abstr. Int., B)

12879 STRUCTURE AND STABILITY OF RAPIDLY ROTATING SUPERMASSIVE STARS. Fahlman, Gregory Gaylord. Toronton; Univ. of Toronto (1970). National Library of Canada, Ottawa).

Thesis.

The study of uniformly rotating polytropes with axial symmetry is extended to include all rotational terms of order Ω^4, where Ω is the angular velocity, consistently within the first post-Newtonian approximation to general relativity. The theory is developed for the particular purpose of investigating the structure and stability of rapidly rotating supermassive stars. These configurations are a mixture of ideal gas and radiation, and throughout the theory, it is assumed that β, the ratio of gas pressure to total pressure, is a constant. The standard model of a supermassive star, a polytrope of index three, is adopted. This is the only polytropic case for which numerical results are discussed. A brief discussion of two quasi-stellar objects, 3C345 and 3C454.3, is given. These two objects are regarded as the best observational candidates for a supermassive star because of their recently reported periodic optical variability. However, on the basis of the results obtained, it is concluded that they cannot be uniformly rotating supermassive stars. The desirability of extending the present work to include the effects of nonuniform rotation and magnetoturbulence is indicated. (TSS) (Diss. Abstr. Int., B)

12880 CORE HELIUM BURNING EVOLUTION AT 15 $M_\odot$. Robertson, J. W. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust.; 2: No. 1, 23-4(Jul 1971).

Fifteen $M_\odot$ models were evolved using the initial abundances (X,Y,Z) = (0.602, 0.354, 0.044) from initial main sequence to core helium exhaustion for the 2 hypotheses, composition gradient ignored (1) and included (2). Case (1) models spend about 70% of core-He-burning lifetime as spectral types F and earlier, then move rapidly to the red-supergiant region for the remaining 30%. Case (2) models move to the red-supergiant region before the ignition of helium-burning reactions. After spending about 30% of core He burning time thus, they rapidly return to the blue supergiant region for the remainder. Following exhaustion of He they return to the red-supergiant region. The relative amount of time spent in the blue region compared to the red region for both cases was similar. (Australia)

12881 CORE HELIUM BURNING EVOLUTION AT 5$M_\odot$. Robertson, J. W. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust.; 2: No. 1, 24-5(Jul 1971).

Upon reduction of core He abundance during core He burning, a He–C–O semiconvective zone may grow outside the fully convective core. Models of 5$M_\odot$ are evolved from the initial main sequence through the bluest point of the Cepheid loops traversed during burning for compositions (X,Y,Z) = (0.602, 0.354, 0.044), (0.708, 0.272, 0.020), and (0.617, 0.363; 0.020). Dependence of the bluest point of the loops on Y and Z may be approximated by $\Delta \log T_e = 1.31\ \Delta Y - 3.9\ \Delta Z$ with $\Delta \log L = 3.8\ \Delta Y - 10.4\ \Delta Z$. (Australia)

12882 POPULATION I HELIUM BURNING RED GIANTS. OBSERVATIONS. Cannon, R. D. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust.; 2: No. 1, 25-6(Jul 1971).

A description is given of observations of the internal structure of the clump in the C–M diagram for NGC 2477 cluster. The existence of the clump implies a slow phase of evolution (about 2×10^8 yrs) for clusters of all ages. The position is typically at $Mv = +1$, $B-V = +1.0$. The size covers ranges of $\Delta \log L/L_\odot = 0.25$, $\Delta \log T_e \lesssim 0.02$. The clump is constant in position from cluster to cluster for ages from 3×10^8 to 10^{10} years. (Australia)

12883 POPULATION I HELIUM BURNING RED GIANTS. THEORY. Faulkner, D. J. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust.; 2: No. 1, 26-7(Jul 1971).

Preliminary results of evolutionary calculations to test the observational evidence of a distinct concentration of stars near the base of the red-giant branch in intermediate galactic clusters, are presented. The identification of these stars with the He core-burning phase of evolution is confirmed. (Australia)

12884 HELIUM ABUNDANCE DETERMINATIONS IN MAIN SEQUENCE B STARS. Simpson, R. W. (Univ. of Queensland, Brisbane). Proc. Astron. Soc. Aust.; 2: No. 1, 27-30(Jul 1971).

Comparison is made between theoretical and observed equivalent widths for the 4438- and 5048-Å He I lines and for the strong overlapping 4026- and 4471-Å He I lines. The results of He abundance determinations for 20 stars are reviewed and assumptions such as LTE are reconsidered. It is thought that for some He I lines it is necessary to use non-LTE theory. (Australia)

12885 ELEMENT ABUNDANCES IN WHITE DWARFS OF SPECTRAL TYPE DF. Wegner, G. (Australian National Univ., Canberra. Univ. of Washington, Seattle). Proc. Astron. Soc. Aust.; 2: No. 1, 30-1(Jul 1971).

Observations were made of L745-46A, R640, and vMa 2. V–r or G–I contours were used to estimate T_{eff}. Model atmospheres were computed consistent with T_{eff}, g, and assumed chemical composition. Abundances varied from star to star. For R640 and vMa 2 $E_{Fe} : E_{Mg} = 1 : 30$ and $1 : 2$, respectively. Metal abundances are lower than most metal-poor stars by more than an order of magnitude. (Australia)

12886 SECONDARY BUMPS IN CEPHEID VARIABLES. Gascoigne, S. C. B. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust.: 2: No. 1, 34(Jul 1971).

Computer phases for three $5M_{\odot}$ models, (X,Y,Z) = (0.602, 0.354, 0.044), (0.708, 0.272, 0.020), and (0.617, 0.363, 0.020) are compared with phases of the secondary bump and period of SMC, LMC, and M31. (Australia)

12887 LOOPS IN THE H–R DIAGRAM DURING CORE HELIUM BURNING AND THE EFFECT OF ROTATION. Meyer-Hofmeister, E. (Max-Planck-Institut fuer Physik and Astrophysik, Munich). Astron. Astrophys.; 16: No. 2, 282-5(Jan 1972).

Evolutionary tracks were computed for nonrotating and for rotating stars of 5, 6, and 9 solar masses to study the influence of rotation on the loops in the H-R diagram during core helium burning. The tracks of the rotating stars show longer loops. This result can be understood as a consequence of the differing hydrogen content left behind in the phase of hydrogen core burning off the main sequence and the increased time scale of helium core burning for rotating stars. (auth)

12888 COOLING AND RECOMBINATION IN INTERSTELLAR MATERIAL IONIZED BY SUPERNOVAE. Goldsmith, Donald (Univ. of California, Berkeley). Astron. Astrophys.; 16: No. 2, 286-90(Jan 1972).

Detailed calculations of the cooling and recombining interstellar gas, together with a one-dimensional hydrodynamic approximation, model the behavior of interstellar material that has been exposed to a supernova explosion and either partially or totally ionized. These calculations show that although supernova outbursts could produce the electron density observed in the interstellar medium, the gas containing these electrons would have temperatures in the range 20 to 100°K, because the cooling time from $T = 10^4$ °K to T = 100°K in a gas with n = 0.3 cm^{-3} is only 10^5 years for an initial ionization fraction of unity, or 2×10^5 years if this fraction is $10^{-0.5}$. Such cool gas would produce a free–free absorption at 10 MHz several times greater than the amount observed. In addition, an analysis of the behavior of initial isobaric perturbations about $T = 10^4$ °K, n = 0.3 particles cm^{-3} and a wavelength of 10^{19} cm shows that the density contrasts at the point T = 20°K do not reach a factor of four, owing to the rapid cooling of the material. Thus an additional mechanism to form interstellar clouds from the background material is required by the time-dependent model; this contrasts with the thermal instabilities that can produce clouds in the models based on steady heating and ionization by x rays or by low-energy cosmic rays. (auth)

12889 HAMBURG SCHMIDT-CAMERA SURVEY OF FAINT PLANETARY NEBULAE. CYGNUS–PERSEUS REGION. Kohoutek, L. (Hamburg Observatory). Astron. Astrophys.; 16: No. 2, 291-300(Jan 1972).

The third part of the H_{α} Schmidt-camera survey of faint planetary nebulae contains the remaining area in the northern Milky Way l 70 to 146°, b ± 10°. Thirty-two new planetary nebulae were classified—6 of which were identical with the objects discovered very recently by Kazarjan and Parsamjan—and measured on the Palomar Sky Atlas. For the new nebulae the concentration toward the galactic equator was found higher than those already known. In the Appendix three compact small H II regions are described. (auth)

12890 FINE ANALYSIS OF TWO EARLY B-TYPE SUPERGIANTS, HD 96248 AND HD 164402, RELATIVE TO THE MAIN SEQUENCE STAR τ SCORPII. Dufton, P. L. (Cambridge Univ., Eng.). Astron. Astrophys.; 16: No. 2, 301-14(Jan 1972).

Model atmosphere analyses are presented for two supergiants HD 96248 (B1Iab) and HD 164402 (B0Ib) relative to the main-sequence star τ Scorpii (B0V). Atmospheric parameters are T_{eff} = 26000°K (from Balmer discontinuity and ionization equilibria), log g = 3.3 (hydrogen line profiles and ESW theory), and ξ_t = 10 km/s (derived abundances independent of equivalent width) for HD 96248 and (33000, 4.1, 10) and (34000, 4.8, 5) for HD 164402 and τ Sco. HD 164402 has a normal composition for an early B-type star while HD 96248 is underabundant in nitrogen and neon by factors of three and six and possibly overabundant in magnesium and silicon. From a comparison with theoretical evolutionary tracks, masses of between 17 and 23 $M_{\odot}$ are deduced for both supergiants. HD 164402 has evolved from the main sequence but is still in a hydrogen-core-burning phase. The status of HD 96248 is uncertain, but the star may be in a hydrogen-shell-burning phase and evolving rapidly to the red-supergiant part of the Hertzsprung–Russell diagram. The abundance anomalies in HD 96248 cannot be explained as an evolutionary effect, and hence may have been present in the material from which the star was formed. (auth)

12891 OPEN CLUSTER NGC 6811. Lindoff, U. (Lund Observatory, Sweden). Astron. Astrophys.; 16: No. 2, 315-21 (Jan 1972).

Magnitudes and colors in the UBV-system were determined for 377 stars in the open cluster NGC 6811 based on a combination of photoelectric and photographic photometry. Spectral classes for 40 relatively brighter stars were determined from objective prism-plates. The color excess E_{B-V} was 0.17m for NGC 6811 and the distance 1100 pc. The age was estimated to 5×10^8 years. (auth)

12892 INFRARED OBSERVATIONS OF 1612-MHz IR/OH SOURCES. Hyland, A. R.; Becklin, E. E.; Frogel, J. A.; Neugebauer, G. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astron. Astrophys.; 16: No. 2, 204-19(Jan 1972).

Infrared spectra and photometry are given for several infrared objects known to have 1612-MHz OH emission. These IR/OH sources are shown to be either M-type Mira variables or M supergiants with photospheric temperatures around 2000°K. All those examined were oxygen rich and none were carbon stars, which suggested a high abundance of OH in their photospheres. A significant fraction of the total luminosity is emitted in the infrared beyond 3.5 μ which was taken to imply a dust shell structure around the central star. There is no evidence which uniquely requires that infrared pumping of the OH maser is taking place; there are, however, generally enough near-infrared photons to supply the observed microwave energy. (auth)

12893 GLOBULAR CLUSTERS NGC 6362 AND NGC 6752. Alcaino, G. (Univ. Catolica de Chile, Santiago). Astron. Astrophys.; 16: No. 2, 220-9(Jan 1972).

A BV photographic investigation on the globular clusters NGC 6362 and NGC 6752 was carried out at the Cerro Tololo Inter-American Observatory (CTIO) with the 1.5 meter reflector and the plate material was reduced with the iris photometer of the European Southern Observatory. For NGC 6362, 235 stars were calibrated photographically from a photoelectric sequence of 61 stars previously obtained by the author at CTIO. The apparent distance modulus is $(m - M)_{app} = 14.8$. The reddening is $E(B - V) = 0.11$. The true distance modulus is $(m - M)_0 = 14.47$. The distance is 7830 pc from the Sun and 2290 pc from the galactic plane. The giant branch rises 2.5 magnitudes above the horizontal branch at $(B - V)_0 = 1.4$, characteristic of intermediate metallicity. For NGC 6752, 339 stars were calibrated photographically from 71 stars previously obtained by the author at CTIO. The apparent distance modulus is $(m - M)_{app} = 13.50$, and no reddening is derived. The distance is 5010 pc from the Sun and 2200 pc from the galactic plane. The giant branch rises 2.9 magnitudes above the horizontal branch at $(B - V)_0 = 1.4$, characteristic of a metal-poor cluster. (auth)

12894 EXCITATION TEMPERATURES IN LATE G- AND K-GIANT ATMOSPHERES. Koelbloed, D. (Univ., Amsterdam). Astron. Astrophys.; 16: No. 2, 230-6(Jan 1972).

Excitation temperatures for Fe I and Ti I for late G- and K-type giants were obtained, using curves of growth (COG). These values were compared with model atmosphere predictions. Whereas there was a satisfactory agreement for Ti I, the COG results for Fe I gave higher temperatures than the LTE models considered. (auth)

12895 SPECTRUM OF THE TYPE-I SUPERNOVA OF 1954 IN NGC 4214. Branch, D. (Royal Greenwich Observatory, Hailsham, Eng.). Astron. Astrophys.; 16: No. 2, 247-51(Jan 1972).

Intensity minima in the spectrum of SN 4214 are interpreted as blueshifted He I absorption lines, as originally suggested by McLaughlin. The light curve and spectral evolution during observed phases were not consistent with a simple model of an expanding photosphere in which lines and continuum were formed, nor was the apparent temperature high enough to account for excitation of He I lines. The observed light curve and continuous energy distribution may have been influenced by solid-particle condensation. (auth)

12896 NEBULOSITY SURROUNDING THE GALACTIC CEPHEID RS PUPPIS. Havlen, R. J. (Univ. of Arizona, Tucson). Astron. Astrophys.; 16: No. 2, 252-67(Jan 1972).

The circularly symmetric, ring-structured reflection nebula surrounding the 41.4-day-period galactic Cepheid RS Puppis was investigated for spatial and time variations in its structure and light intensity. Isodensitracings of several nebular features showed no spatial variations but did show variations in light intensity with a period commensurate with that of the Cepheid. The nebular arcs were interpreted physically as higher-density re-

gions of reflecting material surrounding the Cepheid in space. Further, they were incorporated in a more general spherically symmetric model of reflecting shells which are most visible when viewed tangentially near the plane of the sky. By using this model, artificially constructed nebular light and color curves were fitted to the observations and a simple iterative scheme used to determine the Cepheid's distance as 1.78 ± 0.20 kpc. The true nebular color corrected for the Cepheid light variation reddens strongly radially outwards in accordance with its properties as a reflection nebula. Similarly, the mean radial surface brightness distribution falls intermediate between a r^{-1} and r^{-3} dependence. The total mass of nebular dust was found to be 0.03 $M_{\odot}$. The formation and evolution of the Cepheid–nebula system is discussed, and the suggestion is made that the nebula was structured under the strong influence of the Cepheid during its previous evolutionary phases as a red giant with the accompanying material ejection and sweeping up of the ambient interstellar medium. (auth)

12897 OUTER ENVELOPES AND COOLING OF WHITE DWARFS. Koester, D. (Univ., Kiel). Astron. Astrophys.; 16: No. 3, 459-70(Feb 1972).

The structure and energy transport of the nondegenerate envelopes of white dwarfs in the range 0.32 to 1.17 $M_{\odot}$ with effective temperatures from 6000 to 3000 °K were examined, using newly evaluated opacities. Calculations taking into account convection according to the mixing length theory predict central temperatures up to 25% lower than those of models in radiative equilibrium, if the nondegenerate envelope consists mainly of helium. In hydrogen-rich envelopes the convection zone is relatively thin and the influence on central temperatures is small. In both cases solar values were taken for the metal abundances. Resulting relations between luminosities and central temperatures were used to calculate the cooling of white dwarfs. The density dependence of the specific heat of electrons and ions was fully taken into account. The relative importance of parameters such as mass, chemical composition of envelope, and degenerate interior, as well as different theories of crystallization on cooling and age of white dwarfs are discussed. Resulting luminosity functions show no indication of "crystallization sequences". The cooling times vary strongly with interior composition but are nearly equal for hydrogen or helium envelope. Cooling below the Debye temperature takes place at rather low luminosities and the resulting accelerated cooling should not be observable at present. The calculated ages for carbon white dwarfs are consistent with other estimates for observed objects. In particular there should be no white dwarf with luminosity $\log L/L_{\odot} \geq -4.5$ older than 5 to 6×10^9 years. (auth)

12898 PHOTOELECTRIC OBSERVATIONS OF THE ULTRA-SHORT-PERIOD VARIABLE V567 OPHIUCHI. De Bruyn, A. G. (Sterrewacht, Leiden). Astron. Astrophys.; 16: No. 3, 478-81 (Feb 1972).

Photoelectric five-color observations of V567 Oph show that there remains doubt about the period of this variable, as given by Hoffmeister (1941). Its relative spectral energy distribution appears to be the same as that of RS Gru, a stable variable with a period of 0.147d. (auth)

12899 SPECTROPHOTOMETRY OF THE WHITE DWARF VAN MAANEN 2. Boehm, K. H.; Schwartz, R.; Szkody, P.; Wegner, G. (Univ. of Washington, Seattle). Astron. Astrophys.; 16: No. 3, 431-6(Feb 1972).

The energy distribution in the 3500 to 6600-Å region of the spectrum of van Maanen 2 was determined. Five spectra with dispersions of 51 and 134 Å/mm were used. Line profiles and the structure of blends were visible in considerable detail. The metal line blends in the ultraviolet showed a slightly more detailed structure than measured by Weideman (1960). Only extremely weak lines and blends were seen longward of the Ca II H line. The Ca I 4226 line and the Mg I 5167/5173/5184 blend seemed to be barely detectable. The NaD lines were not visible. (auth)

12900 ELEVEN-BAND PHOTOMETRY OF THE MAGNETIC VARIABLE HD 125248. Maitzen, H. M.; Moffat, A. F. J. (Ruhr Univ., Bochum, Ger.). Astron. Astrophys.; 16: No. 3, 385-94 (Feb 1972). (In German).

The continuum intensity distribution of the AOp-star HD 125248 was obtained relative to that of the comparison star HD 124683 (B9 V) from photoelectric observations using the filters: UBV, uvby, Hβ-wide, Hα-wide, and two intermediate band filters centered on λλ 5030 and 5240 Å. (W.D.M.)

12901 NOVA MENSAE 1970 b IN THE LARGE MAGELLANIC CLOUD. Havlen, R. J.; West, R. M.; Westerlund, B. E. (European Southern Observatory, Santiago de Chile). Astron. Astrophys.; 16: No. 3, 404-7(Feb 1972).

The mean radial velocity of the emission lines of Nova Mensae 1970b is +272 km/s. This indicates that it is a member of the Large Magellanic Cloud; the latter has an average velocity of about +275 km/s. The observed velocity of the shell of the nova is −1560 km/s. The photometry as well as the spectroscopy indicates that the nova is of the very fast type. The observed colors and color variations imply that the first photoelectric observation was obtained seven days past maximum. An extrapolation of the apparent visual magnitude of the nova backwards to the date of maximum gives $V_{max} = 10.8$ mag. With a distance modulus of $m - M = 18.5$ for the Large Cloud for the nova at maximum an absolute visual magnitude, $M_V = -7.7$ mag, was found. (auth)

12902 GLOBULAR CLUSTERS NGC 6304 AND NGC 6401. Terzan, A.; Rutily, B. (Observatoire, Lyon). Astron. Astrophys.; 16: No. 3, 408-16(Feb 1972). (In French).

The photometric study of the plates obtained in 1968 and 1970 at the Newtonian focus of the 80-cm (f/6), 193-cm (f/5) telescopes of the Haute Provence Observatory, and with the Schmidt telescope (48-inch) of Mount Palomar enabled the authors to: (1) make sequences of red (m_r; $\lambda_{eff} \simeq 6400$ Å) and infrared magnitudes (m_{ir}; $\lambda_{eff} = 8100$ Å) about the globular cluster NGC 6304; (2) establish a new sequence m_r in the field of the globular cluster NGC 6401; (3) reveal 102 new variable stars around the cluster NGC 6401; one of them (no. 41) seems to belong to the cluster; and (4) measure the extreme values m_1 and m_2 of these 102 new variable stars and to have a general view of their average brightness and amplitudes. (auth)

12903 EFFECTS OF NUCLEAR REACTIONS ON THE STABILITY OF DEGENERATE STARS. Gabriel, M.; Chanmugam, G. (Univ., Liege). Astron. Astrophys.; 16: No. 3, 369-73(Feb 1972).

The effects of changes in chemical composition on the stability of degenerate stars toward adiabatic radial perturbations are considered. It is shown that degenerate stars, which are dynamically stable when it is assumed that no change in composition occurs but unstable if it is supposed that the reactions are fast enough to allow the chemical composition to adjust instantaneously to any perturbation, are also unstable when the variations in composition are correctly taken into account. The eigenvalues of the problem are very different from those of dynamical stability, i.e., the accelerations are negligible. Therefore the stability problem discussed is distinguished from dynamical stability by naming it dynamical nuclear stability. (auth)

12904 TIME-DEPENDENT RADIATIVE TRANSFER. DAMPING OF A TEMPERATURE FLUCTUATION. I. NEAR LTE GREY APPROXIMATION. Delache, Ph.; Froeschle, Ch. (Observatoire, Nice). Astron. Astrophys.; 16: No. 3, 348-55(Feb 1972).

The time of flight of the photon is taken into account to establish the equations describing the evolution of a small perturbation applied to a grey and homogeneous medium near LTE. It is shown that the solution decays exponentially and thus a previous result obtained by Spiegel (1957) is generalized. It appears that the analytic solution of this problem is possible only for a particular class of perturbations. However, in using Eddington's approximation, the same problem is solved for more general initial conditions. In particular, three types of homogeneous perturbations are obtained that behave in very different ways and that are easy to interpret physically. (auth)

12905 SPECTRAL PROPERTIES OF LUMINOUS LATE-TYPE STARS. Gahm, Goesta F.; Hultqvist, Lennart (Stockholm Observatory). Astron. Astrophys.; 16: No. 3, 329-43(Feb 1972).

Some spectral characteristics observed from 16 Å/mm plates covering the visual-red spectral region of 52 luminous stars of spectral classes K0 to M7 are surveyed. Of these stars 11 are of luminosity class III and 41 of class II or I, including 17 supergiants belonging to the I Per association. New spectral types are given for 13 stars. (W.D.M.)

12906 BLACK HOLES AND BINARY STARS. Batten, A. H.; Olowin, R. P. (Dominion Astrophysical Observatory, Victoria, B. C.). Nature (London); 234: No. 5328, 341-2(10 Dec 1971).

Reference is made to Gibbons and Hawking (Nature 232: 465 (1971)), who suggested that some binary stars contain black holes, and it is stated that there are two implicit assumptions in their argument that, in the opinion of the present authors, are not justified. The formation of a black hole in a binary system would be

accompanied by a sudden loss of mass from the system, and Gibbons and Hawking consider that this mass loss could convert an initially circular orbit into an appreciably elliptical orbit. The first unjustifiable assumption is that the true frequency distribution of orbital eccentricities is similar to their observed distribution, and the second is that the observed frequency distribution is expected to be the same for single-line and double-line spectroscopic binaries. Reasons for questioning these assumptions are given. A reply by Gibbons and Hawking is included. (UK)

12907 FURTHER EVIDENCE FOR COLLAPSED OBJECTS IN BINARY-STAR SYSTEMS. Gott, J. R. (Princeton Univ., N. J.). Nature (London); 234: No. 5328, 342-3(10 Dec 1971).

It is stated that it would be of great interest to discover a collapsed object (neutron star or black hole) as one component of a binary-star system, and a list of 50 candidate systems was compiled from the Batten catalogue, all noneclipsing single-line spectroscopic binaries in which the unseen companion has an estimated mass >1.4 M, and could, in principle, be a neutron star or black hole. Reference is made to Gibbons and Hawking (Nature 232: 465(1971)), who presented evidence suggesting that one or more of the systems on the above-mentioned list contains collapsed objects, and their argument is discussed. A test of the Gibbons–Hawking hypothesis is presented, taking into account the fact that a high eccentricity is not the only consequence of a sudden mass loss. It was found that there are a number of high-eccentricity systems on the candidate list, and a strong correlation was found between velocities and high eccentricities. The evidence supports the suggestion that the high eccentricity systems considered may harbour a neutron star or black hole. (UK)

12908 FURTHER EVIDENCE FOR A BLACK HOLE IN β LYRAE. Wilson, R. E. (Univ. of Southern Florida, Tampa). Nature (London); 234: No. 5329, 406-7(17 Dec 1971).

It has been stated that the observational peculiarities of this binary system can best be understood in terms of the secondary mass being a collapsed star (black hole) surrounded by an opaque or nearly opaque disk, and this communication shows that the recently released uv photometry data from the Orbiting Astronomical Observatory leads to the same conclusion. The observed features of the secondary energy source—very "blue" spectral energy distribution, spatial concentration in the center of a cloud or disk of material, and much lower luminosity than expected for a star of the indicated mass—strongly suggest that accretion of matter by a highly condensed mass is responsible, and since the required mass is of the order of 20 $M_\odot$, there is only one candidate—a star that has collapsed to its gravitational radius. (UK)

12909 NEUTRON STARS AND BLACK HOLES. Sofia, S. (Univ. of Southern Florida, Tampa). Nature (London) Phys. Sci.; 234: No. 51, 155-7(20 Dec 1971).

The characteristics of an object undergoing gravitational collapse that determine whether the end result is a neutron star or a black hole are examined. Although mass has been considered to be the main factor, there is at least preliminary evidence to the contrary. In supernova events it has been shown that shells are ejected having masses > $5M_\odot$ and possibly as large as $40_\odot$, while the mass of the collapsed object is low, that associated with the binary system E Aurigae being estimated at only about 12 $M_\odot$ and that for β Lyrae at $\leq$20 $M_\odot$. Before attempting to solve this problem, an attempt is made to identify the mechanism responsible for shell ejection during a supernova explosion and various proposed mechanisms are examined. A mechanism in which the rotational velocity of the star plays a crucial role is favored. If this velocity is very high, a large amount of matter is shed and the remaining core can settle down as a neutron star; if, on the other hand, the rotational velocity is very low, the remaining core will exceed the maximum neutron star mass ($\sim 2M_\odot$) and the object becomes a black hole. The limiting criterion is derived and applied to stellar models of masses 5, 7, 10, and 25 $M_\odot$. Rotational instability cannot impart to the separated disk the large observed velocities of expansion, but a mechanism is proposed that can do this. (UK)

12910 YOUNG PULSARS: PULSED NEUTRON SOURCES. Truemper, J. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Int. Astron. Union Symp.; No. 46, 384-5(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The prospects of observing a pulsed neutron flux at very high energies from pulsars are discussed. Most likely candidates are the Vela pulsar at 2×10^{16} eV and the Crab pulsar at 10^{17} eV. (auth)

12911 GENERAL-RELATIVISTIC NEUTRON AND HYPERON STAR MODELS. Heintzmann, H. (Univ., Cologne). Rend. Scu. Int. Fis. Enrico Fermi; 47: 359-61(1971).

The question of how much the general features of neutron star models change if one is willing to accept any equation of state that does not contradict present-day physics is considered. A new exact solution of Einstein's field equations is used that is flexible enough to represent many equations of state, the use of which can be justified by different assumptions about the underlying nuclear forces. (W.D.M.)

12912 RELATIVISTIC HYDRODYNAMICS IN SUPERNOVAE. Teller, E. (Univ. of California, Livermore). Rend. Scu. Int. Fis. Enrico Fermi; 48: 402-18(1971).

A supernova explosion cannot be discussed without the study of relativistic hydrodynamics. The discussion of such hydrodynamical equations is the main purpose of this lecture. (W.D.M.)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 13478.

12913 HIGH-RESOLUTION OBSERVATIONS OF THE GALACTIC CENTER AT 5 GHz. Ekers, R. D. (Owens Valley Radio Observatory, Pasadena, Calif. Inst. of Theoretical Astronomy, Cambridge, Eng.); Lynden-Bell, D. Astrophys. Lett.; 9: No. 4, 189-93 (Nov-Dec 1971).

Interferometric observations at 5 GHz with a resolution of 6×18 arc sec indicated the presence of compact components in Sagittarius A and in some of the other radio sources in the galactic center region. (auth)

12914 PRECURSOR PULSE FROM NP 0532: A RESULT OF SCATTERING. Komesaroff, M. M. (CSIRO, Sydney). Astrophys. Lett.; 9: No. 4, 195-200(Nov-Dec 1971).

It is shown that most of the observed properties of the precursor pulse from NP 0532 can be explained by assuming that the precursor results from radiation scattered out of the main pulse beam by a ring of material centered on the pulsar. If the radius of the ring is just greater than that of the velocity-of-light cylinder, the approximate shape, the arrival time, and the high degree and invariant position angle of the linear polarization are explained in simple geometric terms. (auth)

12915 INVESTIGATION OF PULSE-HEIGHT FLUCTUATIONS OF FOUR PULSARS. McCutcheon, W. H.; Shutter, W. L. H. (Univ. of British Columbia, Vancouver). Astrophys. Lett.; 9: No. 4, 201-4(Nov-Dec 1971).

The pulsars CP0329, CP0950, CP1133, and CP1919 were investigated for periodic fluctuations in their pulse amplitudes. Power spectral analysis of integrated pulse amplitudes at 408 MHz showed no periodicities that could be classed as intrinsic to the source. However, the same analysis over narrow time windows of the pulse profiles of CP1133 and CP1919 exhibited the periodicities that have been seen over the integrated pulse at lower radio frequencies. CP0329 and CP0950 exhibited only pulse-to-pulse correlations. (auth)

12916 POLARIZATION OF THE DRIFTING SUBPULSES OF PULSAR 0809 + 74. Taylor, J. H. (Univ. of Massachusetts, Amherst); Huguenin, G. R.; Hirsch, R. M.; Manchester, R. N. Astrophys. Lett.; 9: No. 4, 205-8(Nov-Dec 1971).

Individual pulses from PSR 0809 + 74, which exhibits well-organized drifting subpulses, were found to be highly linearly polarized. Variations of the polarization parameters are accurately synchronized with the drifting subpulse pattern. It is suggested that the symmetry axis determining the polarization variation is associated with an emission region which moves systematically with respect to the neutron star. (auth)

12917 BURSTS IN THE RADIOEMISSION OF PULSAR PP 0943. Vitkevich, V. V.; Alekseev, Yu. I.; Zhuravlev, V. F.; Shitov, Yu. P. (Lebedev Inst. of Physics, Moscow). Astrophys. Lett.; 9: No. 4, 209-10(Nov-Dec 1971).

Occasional strong increases in intensity occur in the radio emission from Pulsar PP 0943. (auth)

12918 DETECTION OF THE ^{18}O ISOTOPE OF FORMALDEHYDE AT 4388 MHz. Gardner, F. F.; Ribes, J. C.; Cooper, B. F. C. (CSIRO, Sydney). Astrophys. Lett.; 9: No. 4, 181-3(Nov-Dec 1971).

The $1_{11}-1_{10}$ line of $^{12}CH_2{}^{18}O$ at 4388 MHz was detected in Sgr B2 with a peak optical depth in absorption of ~0.01 and a half-

width of 23 km/sec. A comparison of the absorption from $^{12}CH_2{}^{18}O$, $^{13}CH_2{}^{16}O$, and $^{12}CH_2{}^{16}O$ shows that the abundance ratio (^{13}C: ^{12}C)/(^{18}O: ^{16}O) is about 1.8 times the terrestrial value of 5.5. If the $^{18}O/^{16}O$ ratio is normal then the $^{13}C/^{12}C$ ratio would be 1/50 as compared with the terrestrial 1/89, and the equivalent optical depth for $^{12}CH_2{}^{16}O$ would be about 6. The relative frequencies of the isotopic species are in agreement with the laboratory measurements of Tucker et al. (1971) to within an accuracy of about 10 kHz. (auth)

12919 OBSERVATIONS OF THE EXCITED LINES OF OH NEAR 4700 MHz. Gardner, F. F.; Ribes, J. C. (CSIRO, Sydney). Astrophys. Lett.; 9: No. 4, 175-9(Nov-Dec 1971).

Wide-band (~20 km/sec) OH emission previously found in Sgr B2 at the $^2\Pi_{\frac{1}{2}}$, $J = \frac{1}{2}$, $F = 0 \rightarrow 1$ frequency of 4660 MHz is also present, although weaker, at the $F = 1 \rightarrow 0$ frequency of 4765 MHz at the $F = 1 \rightarrow 1$ frequency of 4750 MHz, the latter being the first astronomical detection of this line. The approximate intensity ratio 4660 : 4750 : 4765 is 5 : 2 : 1, to be compared with the theoretical ratio of 1 : 2 : 1. Profiles of the narrow-band emission at 4765 and 4660 MHz with 1-kHz resolution are presented. Upper limits to broad- or narrow-band emission from four other southern OH sources are given. (auth)

12920 OBSERVATIONS OF OJ 287 AT OPTICAL AND MILLIMETER WAVELENGTHS. Kinman, T. D. (Kitt Peak National Observatory, Tucson, Ariz.); Conklin, E. K. Astrophys. Lett.; 9: No. 4, 147-9(Nov-Dec 1971).

The radio source OJ 287 varies with a time scale of a few days at both optical and millimeter wavelengths. At optical wavelengths it has a blue continuous spectrum and has a high variable polarization. (auth)

12921 OJ 287: AN EXCEPTIONALLY ACTIVE VARIABLE SOURCE. Andrew, B. H.; Harvey, G. A.; Medd, W. J. (National Research Council of Canada, Ottawa). Astrophys. Lett.; 9: No. 4, 151-4(Nov-Dec 1971).

Observations of the radio source OJ 287 at centimeter wavelengths have shown that it has both rapid variations with time scales of a few days and very strong long term variations. The rapid variations resembled optical variations, which were observed at the same time. (auth)

12922 PROBABLE EFFECTS OF THE TERRESTRIAL ATMOSPHERE ON QUASAR REDSHIFT MEASUREMENTS. Roeder, R. C.; Dyer, C. C. (Kitt Peak National Observatory, Tucson, Ariz.). Nature (London) Phys. Sci.; 235: No. 53, 3-6(3 Jan 1972).

There is a significant correlation between the distribution of the published emission-line redshifts of all quasars with two or more lines in their spectra, on a scale of 0.1 in redshift, and the average number of lines in the spectra. This may be caused by a combination of night-sky emission lines and the finite size of the atmospheric observing window, so that no cosmological (or other) significance should be assigned to the distribution. (auth)

12923 γ-RAY ABSORPTION FOR A BEAM MODEL OF NP 0532. Stecker, F. W.; Tsuruta, S. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London) Phys. Sci.; 235: No. 53, 8-9 (3 Jan 1972).

The possibility of γ-ray absorption near the Crab Nebula was pointed out by McBreen (Nature, 224: 893(1969)), and it was shown (Pollack and others, Astrophys. J., 169: L.113(1971)) that, if this is so, the critical energy above which absorption could be observed to occur could, in principle, be used to determine the size of the emitting region in γ-ray sources such as pulsars, quasars, and supernovae. Previously suggested models, however, have not taken account of beaming in pulsars, such as NP 0532, which has the effect of significantly raising the value of the critical energy, and what is considered to be a more plausible model is suggested for estimating γ-ray absorption from NP 0532. This model involves an assessment of the effect of beaming as indicated by the pulsations themselves. Among findings reached is that it cannot be concluded that absorption will occur below 500 MeV, even if the radiation is emitted at the surface of the pulses, contradicting the findings of Pollack and others. (UK)

12924 ORIGIN OF STRONG MAGNETIC FIELDS. Canuto, V. (Goddard Space Flight Center, New York); Kumar, S.; Lee, H. J. Nature (London) Phys. Sci.; 235: No. 53, 9-10(3 Jan 1972).

A possible mechanism by which the very strong magnetic fields existing in neutron stars and white dwarfs could originate was proposed by the authors in Phys. Rev. Lett., 23: 390(1969), involving the existence of thermodynamic equilibrium states (LOFER states) of an electron gas, which self-consistently maintain the required field provided the temperature is kept below a critical value T_c. Such states are relatively stable, or metastable, and the decay time from any of those states to any other state, including the absolutely stable states, is long enough to make them virtually stable or quasi-stable. It is stated that, since publication of the first papers on the subject, several incorrect papers have appeared concerning the nature and stability of the LOFER states, and the present communication sets out to give the essence of the stability theory of such a state with a view to clearing up the misunderstandings that have occurred. (UK)

12925 CYGNUS X-1: A SPECTROSCOPIC BINARY WITH A HEAVY COMPANION. Webster, B. L.; Murdin, P. (Royal Greenwich Observatory, Hailsham, Eng.). Nature (London); 235: No. 5332, 37-8(7 Jan 1972).

Measurements of the radial velocity of the star HD 226868, which is coincident with the x-ray star Cygnus X-1 and a radio star, over the period Aug to Oct. 1971 indicate that it is velocity-variable and that its changes of velocity correlate with changes in the x-ray flux. Spectrograms were taken with the 98-inch Isaac Newton telescope at RGO. The velocity data could be interpreted as showing that the star (mass M_B) is in a low-eccentricity orbit around a heavy companion (mass m) in the mass relation $m \gtrsim 0.5\ M_B^{\frac{4}{3}}$. On this interpretation of the spectroscopic evidence the system is similar to, but on the short-period fringe of, other spectroscopic binaries containing blue supergiants. In nearly all those systems, however, the supergiant shows emission lines; such lines were not observed in the spectra of HD 226868. The possibility that the velocity variations represent expansion and contraction of the star could not be entirely eliminated. A tentative interpretation of the system is given, identifying the source of x rays with the companion, and giving the value of m as between 2.5 and 6.0 $M_\odot$. It is suggested that the star is not a normal-sequence of supergiant star and that the companion is a white dwarf or neutron star, or may be a black hole. (UK)

12926 OBSERVATIONS OF IC 433 AT 408 MHz. Colla, G.; Fanti, C.; Fanti, R.; (and others) (Univ., Bologna). Astron. J.; 76: No. 10, 953-6(Dec 1971).

High-resolution observations at 408 MHz (3 by 10 arc min) of the supernova remnant IC 443, made using the Northern Cross radiotelescope are presented. An exceptional coincidence between the radio and optical structures of the nebula is shown to exist. The spectral-index was found to be constant over the object, excepting the zones of two small-diameter sources. (auth)

12927 OBSERVATIONS OF CYGNUS LOOP AT 408 MHz. Colla, G.; Fanti, C.; Fanti, R.; (and others) (Univ., Bologna). Astron. J.; 76: No. 10, 956-7(Dec 1971).

High-resolution observations of the Cygnus Loop at 408 MHz are presented. An exceptional coincidence between radio and optical filamentary structure is shown to exist. (auth)

12928 NATURE OF 3C 391. Bridle, A. H.; Kesteven, M. J. L. (Queen's Univ., Kingston, Ont.). Astron. J.; 76: No. 10, 958-64(Dec 1971).

Observations of the neutral-hydrogen absorption profile and microwave continuum emission of 3C 391 are presented. The classification of the source as a supernova remnant is supported, and the nature of its unusual radio continuum spectrum is discussed. The spectrum is most simply explained by postulating that the radiation from the source passes through an H II region situated between 3C 391 and the Sun. Alternative mechanisms, intrinsic to the source, are also discussed. Five experiments are suggested which may provide further understanding of the spectrum. (auth)

12929 STRUCTURE OF P 1934-63. Gubbay, J. S. (Weapons Research Establishment, Salisbury, Australia); Legg, A. J.; Robertson, D. S.; Craske, N.; Nicolson, G. D. Astron. J.; 76: No. 10, 965-9(Dec 1971).

Radio telescopes of the NASA–JPL Deep Space Network near Woomera and near Canberra were operated as an interferometer in the latter part of 1969 and in May 1970 to study the dependence of correlated flux from P 1934 – 63 at 2.3 GHz on the orientation of the baseline. The effective baseline distance varied between 7 and 9 million wavelengths during the observations. It was found that two discrete components accounted for 60% of the flux received. These components are about 0.008 arc sec along their major axes and at a separation of 0.040 arc sec along an east–west direction. There is some evidence of a weak discrete component in motion with respect to the major discrete components. Measurements of the total flux were also made in order to deter-

mine possible secular changes, and a decrease of −0.7% per annum since 1967 was found. (auth)

12930 NRAO 5-GHz RADIO SOURCE SURVEY. I. A SURVEY OF FAINT SOURCES. Davis, M. M. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. J.; 76: No. 10, 980-92(Dec 1971).

Positions and flux densities are given for 254 sources detected in a 190 deg^2 survey at 6-cm wavelength, using the newly resurfaced NRAO 300-ft telescope. The surface density of sources with $|b| > 20°$ at the survey limit of 0.067 flux unit (1 fu = 10^3 mfu = 10^{-26} W m^{-2} Hz^{-1}) is $(2.75 \pm 0.28) \times 10^3$ sr^{-1}. Additional observations determined an rms confusion level of 2.8 ± 0.4 mfu. Forty-two percent of the 108 sources with $S \geq 0.067$ fu and $|b| \geq 20°$ have spectra flatter than $\nu^{-0.5}$ between 408 and 5000 MHz. (auth)

12931 SEARCH FOR OH IN NINE HIGH-LATITUDE SELECTED AREAS. Kerr, F. J.; Knapp, Gillian R. (Univ. of Maryland, College Park). Astron. J.; 76: No. 10, 993-4(Dec 1971).

A search was made for OH emission at nine points at high galactic latitudes. A positive result was obtained for one region, and is thought to originate from a dust cloud at that position. (auth)

12932 PHOTOIONIZATION AND THE EMISSION-LINE SPECTRA OF QUASI-STELLAR OBJECTS. Davidson, Kris (Princeton Univ. Observatory, N. J.). Astrophys. J.; 171: No. 2, 213-31(15 Jan 1972).

Detailed photoionization calculations were used to examine the information conveyed by relative emission-line intensities in QSO spectra. It was found that the elemental abundances cannot be estimated with any assurance; but if "conventional" values are assumed, then certain restrictions may be placed on the ionizing spectra and gas densities. In particular, the ratio between radiation density and gas density was determined. Narrow filaments or sheets of ionized gas seem to be indicated; these may be compressed regions behind shock fronts. (auth)

12933 SPECTRUM OF THE QUASI-STELLAR OBJECT PHL 957. Lowrance, John L. (Princeton Univ. Observatory, N. J.); Morton, Donald C.; Zucchino, Paul; Oke, J. B.; Schmidt, Maarten. Astrophys. J.; 171: No. 2, 233-51(15 Jan 1972).

Spectra of the radio-quiet quasar PHL 957 (V = 16.5 mag) were obtained at the 200-inch telescope with the Cassegrain image tube, the Cassegrain multichannel spectrometer, and an integrating television camera on the coudé spectrograph. The emission lines in the Cassegrain spectra had a redshift of z = 2.69 ± 0.01. In addition, the image-tube spectra revealed 64 absorption lines between 3200 and 6800 Å. The absolute energy distribution indicated that this quasar is one of the most luminous known. The coudé spectrum was obtained from 4270 to 4495 Å with 0.75 Å resolution in a 6-hour exposure with an SEC vidicon. It recorded 31 absorption lines including 10 already found in that region at lower resolution. Several of the lines were resolved and reach zone central intensity, including some in the wing of the Lα emission line, while other lines remain unresolved with Doppler widths of at most 30 km s^{-1}. Four absorption-line redshifts at z = 2.2065, 2.2259, 2.3099, and 2.6624 were identified as very probable. Four others, ranging from 2.0721 to 2.5514, were classed as probable or possible, and two doubtful cases at 1.8242 and 2.1582 were noted. (auth)

12934 UBV OBSERVATIONS OF 3C 273. IV. Burkhead, Martin S.; Stein, William L. (Indiana Univ., Bloomington). Publ. Astron. Soc. Pac.; 83: No. 496, 830-1(Dec 1971).

Observations of 3C 273 for 1970–71 are presented. A rapid change in V magnitude on April 15, 1971, is discussed. (auth)

12935 EVOLUTION OF QUASAR RADIO AND OPTICAL LUMINOSITY. Golden, Leslie M. (Univ. of California, Berkeley). Nature (London) Phys. Sci.; 234: No. 49, 103-6(6 Dec 1971).

Arakelian's method (Nature 225: 358(1970)) of distinguishing between evolution of the optical and radio luminosities of quasars was applied to samples freed from the selection effects not allowed for. It was found, contrary to Arakelian's conclusion, that the optical and radio luminosities of quasars evolve similarly with time. (auth)

12936 INTERPLANETARY SCINTILLATION OF RADIO SOURCES AT METRE WAVELENGTHS. II. THEORY. Readhead, A. C. S. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 155: No. 2, 185-97(1971).

Interplanetary scintillation is being used, in a survey of radio sources, to study angular structure in the range 0·1 to 1′ at a frequency of 81.5 MHz. The application of diffraction theory to scintillation at this frequency is discussed, and the diffracting parameters of the interplanetary medium are derived. The dependence of scintillation index on angular structure and receiver bandwidth is determined. (auth)

12937 LOW-ENERGY X RAYS RULED OUT AS INTERSTELLAR IONIZING MECHANISM TOWARD K3-50. Chaisson, E. J.; Goad, L. E. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 171: No. 2, L61-5(15 Jan 1972).

The H94α and C94α recombination lines (λ3.8 cm) originating in an H I region along the line of sight toward the nebula K3-50 were detected. The fraction of ionized atomic hydrogen was determined to be $(6.8 \pm 5.8) \times 10^{-4}$. In conjunction with a study of neutral hydrogen (λ21 cm), this value implied an electron density of $\sim 10^{-2}$ cm^{-3} in the H I cloud. For this cloud, soft x rays (~100 eV) are ruled out as the interstellar heating mechanism. (auth)

12938 RELAXATION OF ELECTRON VELOCITY IN A ROTATING NEUTRON SUPERFLUID: APPLICATION TO THE RELAXATION OF A PULSAR'S SLOWDOWN RATE. Feibelman, Peter J. (Univ. of Illinois, Urbana). Phys. Rev., D; 4: No. 6, 1589-97(15 Sep 1971).

The relaxation time τ of an average electron velocity relative to a dilute array of vortex cores in a rotating, s-wave-paired neutron superfluid, was estimated. At low temperatures, τ was found to vary exponentially with Δ^2/ϵ_F, the energy scale of vortex core excitations, where Δ is the gap parameter and ϵ_F is the neutron Fermi energy. For reasonable choices of Δ and ϵ_F, values of τ were found which included the values of a year and of several days observed, respectively, in the post-speedup relaxation of the Vela and Crab pulsars' slowdown rates. (auth)

12939 RECENT PROGRESS AND FUTURE PROSPECTS IN HIGH-ENERGY ASTRONOMY. Friedman, Herbert (Naval Research Lab., Washington, D. C.). Astronaut. Aeronaut.; 10: No. 1, 24-8(Jan 1972).

X-ray astronomy nears the end of its first decade of intensive observations. The first small satellite, SAS-1 (Uhura), dedicated to mapping the x-ray sky, caps this period. Results of studies carried out in the past decade are briefly reviewed, and the immediate-future prospects are discussed. (W.D.M.)

12940 INTERPLANETARY SCINTILLATION: INTERSTELLAR SCATTERING OF TWO PULSARS. Zeissig, G. A.; Lovelace, R. V. E. (Univ. of Puerto Rico, Rio Piedras). Astron. Astrophys.; 16: No. 2, 190-6(Jan 1972).

The theory of interplanetary scintillations is discussed for the situation where the incident radiation is scattered in angle and amplitude-modulated by propagation through the more-distant interstellar medium. Observations of interplanetary scintillations of the pulsars CP 0950 and NP 0527 at 318 MHz are described. As a function of solar elongation down to the closest approach to the Sun of 5°, the scintillations of CP 0950 behave as expected for a "point" source. The variation of the modulation index with solar elongation was derived. In contrast with the scintillations of most continuous sources, there is no "turnover" of the index with decreasing elongation. An upper limit on the effective angular size of CP 0950 due to interstellar scattering of $< 4.5 \times 10^{-3}$ s of arc was obtained. Observations on NP 0527 revealed a "turnover" in the interplanetary modulation index which, if interpreted as due to interstellar scattering, implies an angular diameter of $\lesssim 1.5 \times 10^{-2}$ s of arc. (auth)

12941 GREEN BANK SKY SURVEY IN SEARCH OF RADIO SOURCES AT 1400 MHz. II. SPECTRAL PROPERTIES OF THE 5C1 AND 5C2 SOURCES. Maslowski, J. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys.; 16: No. 2, 197-203(Jan 1972).

The results of a 1400-MHz survey of the 5C2 region of the sky, made with the 300-foot radiotelescope of the National Radio Astronomy Observatory, Green Bank, are presented. Forty sources were observed in an area that overlaps 94% of the 5C2 region down to a limiting flux density of 0.09×10^{-26} W m^{-2} Hz^{-1} at 1400 MHz. A comparison of the spectral index distributions between 1400 and 408 MHz for the sources from the 5C1 and 5C2 regions shows that these distributions are significantly different. Sources with flat spectra are more common in the 5C1 than in the 5C2 region. The mean spectral index for the 5C1 sources is 0.36 ± 0.079, while for the 5C2 sources it is 0.79 ± 0.062. Mostly, the 5C2 region contains sources having steep and straight spectra between 5000 MHz and 408 MHz, contrary to the 5C1 region showing sources with flat, inverted and concave spectra in this frequency range. (auth)

12942 LINE INTERACTIONS IN SATURATED MASERS. Bromley, A. G. (Univ. of Sydney). Proc. Astron. Soc. Aust.: 2: No. 1, 34-6(Jul 1971).

Consideration of the possibility of line interactions in masers with very-high-intensity radiation fields led to 4 basic interactions: (1) Saturation of a field causes distortion of energy-level populations in other fields, often severe enough to cause inversion of a radiative transition; (2) A radiation field on saturation may so distort energy-level populations as to cause anti-inversion of a previously saturated radiative transition; (3) A pattern of populations of molecular energy levels may be established such that a second radiation field has one of its component transitions inverted while another is anti-inverted; and (4) Linear, but not circular polarization is expected if the pumping is anisotropic and distinguishes the magnitude, but not the sign of the magnetic quantum numbers of the magnetic sublevels within one hyperfine level. It is thought that the problem of the origin of the circular polarization and the problem of variety of 18-cm OH, emission can be resolved by such a rationale. It was only possible to analyze simplified models of the $^2\pi_{\frac{1}{2}}$, J = ½ ground state of OH, so conclusions directly relevant to 18-cm emission were not drawn. (Australia)

12943 NEW OH EMISSION SOURCES. Robinson, B. J.; Caswell, J. L.; Goss, W. M. (CSIRO, Sydney). Proc. Astron. Soc. Aust.; 2: No. 1, 36-8(Jul 1971).

A search of 218 galactic sources for OH in the longitude range 256 to 352° at 1665 MHz revealed 18 new emission sources; all have since been observed at 1667 MHz and 11 have been observed on the satellite transitions. (Australia)

12944 SYSTEMATIC SEARCH FOR HIGH-VELOCITY HYDROGEN OUTSIDE THE GALACTIC PLANE. II. Kuilenburg, J. v. (Sterrewacht, Leiden). Astron. Astrophys.; 16: No. 2, 276-81(Jan 1972).

A survey is presented of neutral hydrogen with radial velocities between −270 and −60 km/s and +60 and +270 km/s. The drift scans on which the survey is based were separated by 2.5° in declination. The whole sky visible from Dwingeloo, excluding the region $-15° < b < +15°$, was covered. All hydrogen found showed negative velocities except a complex at l = 265°, b = +25°. No definite correlations with other large-scale features (radio spurs, absorption and emission regions) in the sky can be established. (auth)

12945 OBSERVATIONS AT 408 MHz of SUPERNOVA REMNANTS IN THE LMC. Clarke, J. N. (Univ. of Sydney). Proc. Astron. Soc. Aust.: 2: No. 1, 44-5(Jul 1971).

Observations were made during January and March of 1970. Contour levels, positions, declinations, and flux densities are given. (Australia)

12946 DETECTION OF RADIO RECOMBINATION LINES IN FOUR RADIO SOURCES FORMERLY CONSIDERED SUPERNOVA REMNANTS. Wilson, T. L.; Altenhoff, W. J. (Max-Planck-Institut fuer Radioastronomie, Bonn.). Astron. Astrophys.; 16: No. 3, 489-90(Feb 1972).

Eight sources listed by Reifenstein et al. (1970) as having no radio recombination line emission were reobserved, using the NRAO 140-ft radio telescope. Of the eight, radio recombination lines were detected in four. Reasons for the failure to detect the line in the earlier survey and consequences of the present results are briefly discussed. (auth)

12947 INTERFERENCE-FILTER PHOTOGRAPHY OF H II REGIONS. Smith, M. G. (Cerro Tololo Inter-American Observatory, La Serena, Chile). Astron. Astrophys.; 16: No. 3, 482-5 (Feb 1972).

"Mono-ionic," interference-filter, image-tube photographs are presented as an efficient tool for planning accurate observations of parameters dependent on line strengths and line profiles in gaseous nebulae. They provide evidence for considerable small-scale variations in excitation conditions within individual H II regions, such as are already well documented in planetary nebulae. A larger region of enhanced [N II] emission was found near the position of the radio source, Car II. Comparison of Hα and [N II] regions confirmed a recent objection to published temperatures derived from comparison of the linewidths of Hα and [N II] λ6584 Å. (auth)

12948 SEARCH FOR PULSED γ-RAY EMISSION ABOVE 50 MeV FROM THE CRAB NEBULA PULSAR NP 0532. Leray, J. P. (CEN, Saclay, France); Vasseur, J.; Paul, J.; (and others). Astron. Astrophys.; 16: No. 3, 443-58(Feb 1972).

A search for pulsed γ-ray emission above 50 MeV from the Crab Nebula was conducted with a balloon-borne spark-chamber. The results from six flights performed in 1969 are analyzed, but only two of the flights were sufficiently accurate in time to provide good data for pulsar research. If the data for a periodic pulsar profile in phase with radio and optical measurements are analyzed, one finds a two-standard deviation excess of counts at the place of the secondary peak observed at lower wavelengths. This result is not considered to be a statistically positive effect. However, if this excess is attributed to a source in the Crab, then one can give an upper limit to the pulsed γ-ray flux above 100 MeV : 2.5×10^{-5} photon cm^{-2} s^{-1}. (auth)

12949 RESULTS OF AN INITIAL SURVEY OF FINE STRUCTURE IN RADIO SOURCES AT 81.5 MHz. Bell Burnell, S. J. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Astron. Astrophys.; 16: No. 3, 379-84(Feb 1972).

Results are presented from an initial survey at 81.5 MHz that used the technique of interplanetary scintillation to measure the angular diameters of radio sources. 163 sources in the region $-10° < \delta < 45°$, $10_h < \alpha < 16_h$ were studied, and found to contain components with diameters ≤1.0″. (auth)

12950 NEW PROSPECT FOR GAMMA-RAY LINE ASTRONOMY. Clayton, D. D. (Cambridge Univ., Eng. Rice Univ., Houston, Tex.). Nature (London): 234: No. 5327, 291-2(3 Dec 1971).

Gamma-ray line astronomy is discussed in relation to the occurrence of radioactivity in interstellar space and nucleosynthesis of the elements. With regard to the coproduction of the elements in exploding stars, detectable amount of ^{60}Fe may exist in nearby explosive remnants. This nuclide has a half-life of 3×10^5 yr, and the subsequent decay of its ^{60}Co daughter is accompanied by a two-gamma cascade with energies 1.17 and 1.33 MeV. This pair of equal intensity lines can serve to identify ^{60}Fe in interstellar space, and the half-life is long enough to allow the radioactivity to persist long after the explosive event. A simple model discussed is that all solar nuclei were coproduced in 1.7×10^9 explosive events occurring on an average of every 3 yr over the first half of the galactic lifetime, and now occurring once every 30 yr. This model lowers the present supernova yield by peaking nucleosynthesis early. Mechanisms for the production of ^{60}Fe and related nuclides are discussed. With regard to detection, line fluxes should exceed 2×10^{-3}/cm²/sec for balloon detection, or 4×10^{-5}/cm²/sec for satellite detection, and it is suggested that a γ-ray telescope with good energy resolution near 1 MeV might profitably be used to look at nearby supernova remnants and pulsars from a satellite. (UK)

12951 PARAMETERS OF TWELVE WEAK PULSARS AT 327 MHz. Mohan, S. K.; Balasubramanian, V.; Swarup, G. (Tata Inst. of Fundamental Research, Bombay). Nature (London) Phys. Sci.; 234: No. 51, 151-3(20 Dec 1971).

Declination, average pulse energy, and pulse shape at 327 MHz were determined, using the Ooty radiotelescope. The pulsars studied were BP 0740 − 28, BP 2020 + 28, MP 1604 − 00, MP 1944 + 17, MP 0450 − 18, MP 1857 − 26, MP 1706 − 16, MP 0818 − 13, JP 1953 + 29, JP 1845 − 04, JP 1858 + 03, and AP 1541 + 09. The barycentric period was also determined for four of the pulsars. The results indicate that the dependence of average pulse shape on pulse period is not as marked as previously suggested. (UK)

12952 VARIABLE X-RAY SOURCES IN NORMA AND CETUS. Harries, J. R. (Univ. of Adelaide); Tuohy, I. R.; Broderick, A. J.; Fenton, K. B.; Luyendyk, A. P. J. Nature (London) Phys. Sci.; 234: No. 51, 149-51(20 Dec 1971).

In a rocket experiment launched from Woomera on July 10, 1970, the measured flux of Norma X-2 between 2 and 10 keV was found to be significantly higher than previous measured values, implying variability in x-ray emission. Disappearance of the intense source Cetus X-2 was also established, and an upper limit was determined for its flux between 1.5 and 9 keV. The measuring system and its mode of operation are described in detail. (UK)

12953 RECOMBINATION SPECTRA OF GASEOUS NEBULAE. Seaton, M. J. Comments At. Mol. Phys.; 3: No. 2, 46-52(Dec 1971-Jan 1972).

Following the discussion of the theory of radiative recombination (Seaton, Comments At. Mol. Phys., 111: 15(1971)), predictions of the theory are compared with observations of nebulae at both optical and radio wavelengths. Hydrogen and helium lines at optical wavelengths are discussed. It is stated that recently the disagreement between theory and observation for the intensities of the high Balmer lines has been resolved as the photographic calibrations were in error. Much work has been concerned with the interpretation of

the triplet intensities, and it is now realized that the transition $2^3S \rightarrow 1^1S$ can take place with the emission of one photon. The radio continuum and the radio lines are discussed and models considered. (UK)

12954 CRAB NEBULA. International Astronomical Union Symposium Number 46 Held at Jodrell Bank, England, August 5–7, 1970. Davies, R. D.; Smith, F. G. (ed.). Dordrecht, Netherlands; D. Reidel Publishing Company (1971). 484p. (CONF-700849).

Sessions were held on observations of the Crab Nebula, observations of NP 0532, observations of other pulsars, relation of Crab Nebula to other supernova remnants, physics of the Crab Nebula, physics of the neutron star, energy considerations and the electrodynamic link between the pulsar and the Nebula, and radiation mechanisms of the pulsar. Separate abstracts were prepared for 66 of the 69 papers presented. (W.D.M.)

For abstracts of individual papers see: 12910 and 12955–13019.

12955 OPTICAL OBSERVATIONS OF THE CRAB NEBULA. Trimble, Virginia (Cambridge Univ., Eng.). Int. Astron. Union Symp.; No. 46, 3-11(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The continuum radiation from the Crab Nebula has a great deal of structure, the majority of which is strongly polarized. Wisps in the vicinity of the pulsar at the center of the nebula move noticeably in a few months. The appearance of the nebula changes markedly when photographed in different emission lines as a result of the variations of physical conditions from place to place within the nebula. (auth)

12956 DYNAMICS OF THE CRAB NEBULA. Trimble, Virginia (Cambridge Univ., Eng.). Int. Astron. Union Symp.; No. 46, 12-21(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Studies of the proper motion of many filaments in the Crab Nebula show that the expansion center does not coincide with the present position of the pulsar NP 0532. Possible reasons for this difference are discussed. Estimates of the turbulent velocity within the nebula indicate that it lies in the range 100 to 300 km sec^{-1}. An analysis of the present expansion rate of the nebula indicates a convergence at 1140 ± 10 AD. The acceleration implied in this result could arise from magnetic or relativistic electron pressure. (auth)

12957 ELECTROMAGNETIC SPECTRUM OF THE CRAB NEBULA. Baldwin, J. E. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Int. Astron. Union Symp.; No. 46, 22-31(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Observations of the spectrum of the integrated emission from the Crab Nebula are discussed. The radio data with accurate calibrations lead to a flux density spectral index of −0.26. Discrepancies in the published fluxes at millimeter wavelengths can be resolved if appropriate angular dimensions are used. In the optical range the spectral index has increased to a value of −0.9 if 1.0m of absorption is used. At x-ray wavelengths the spectral index has increased further to −1.2. (auth)

12958 SEARCHES FOR γ RAYS FROM THE CRAB NEBULA AND ITS PULSAR. Jelley, J. V. (Atomic Energy Research Establishment, Harwell, Eng.). Int. Astron. Union Symp.; No. 46, 32-41(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The Crab Nebula has been regarded as the most promising celestial object to investigate for the detection of γ rays. Gamma-ray emission might be expected from either the synchrotron or the inverse Compton mechanism. Periodic γ-ray emission could come from the pulsar, but no theory has yet been developed for such objects. Searches for γ rays from both the Crab Nebula and the Crab pulsar made by a number of groups are described. Limits have been set to the γ-ray emission from both objects that are only a little above the extrapolated optical and x-ray fluxes. (auth)

12959 X-RAY OBSERVATIONS OF THE CRAB NEBULA. Kellogg, Edwin M. (American Science and Engineering, Cambridge, Mass.). Int. Astron. Union Symp.; No. 46, 42-53(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

X-ray observations made on the Crab Nebula are reviewed. They include angular size, location, energy spectrum as high as 560 keV, upper limits on time variability and line emission, interstellar absorption, and polarization. Some data on the x-ray spectrum of the pulsar NP 0532 are included. The x-ray luminosity versus radius of the Crab, compared with that of other known x-ray-emitting supernova remnants, is also discussed. (auth)

12960 UPPER LIMIT OF THE X-RAY POLARIZATION OF THE CRAB NEBULA. Novick, R.; Angel, J. R. P.; Wolff, R. S. (Columbia Univ., New York). Int. Astron. Union Symp.; No. 46, 54-64(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

A rocket-borne x-ray polarimeter was flown to search for polarization in Taurus X-1. Although a result consistent with zero polarization was obtained, the statistics were such that x-ray polarization comparable in magnitude and direction to that of radio and optical continuum emission cannot be excluded. (auth)

12961 RECENT RESULTS ON THE SEARCH FOR 10^{11} eV GAMMA RAYS FROM THE CRAB NEBULA. Fazio, G. G.; Helmken, H. F.; Rieke, G. H.; Weekes, T. C. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Int. Astron. Union Symp.; No. 46, 65-7(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The detection of Cherenkov light emitted by cosmic-ray air showers was used to search for cosmic gamma rays from the Crab Nebula. By use of the 10-m optical reflector at Mt. Hopkins, Arizona, the Crab Nebula was observed during the winter of 1969–1970 for approximately 112 hours, which was a significant increase in exposure time over previous experiments. Above a gamma-ray energy of 2.2×10^{11} eV, no significant flux was detected, resulting in an upper limit to the flux of 8.1×10^{-11} photon/cm^2 sec. In the synchrotron–Compton-scattering model of gamma-ray production in the Crab Nebula, this limit on the flux indicates the average magnetic field in the nebula must be greater than 3×10^{-4} G. (auth)

12962 HIGH RESOLUTION MAPS OF THE CRAB NEBULA AT 2700 MHz AND 5000 MHz. Wilson, A. S. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Int. Astron. Union Symp.; No. 46, 68-70(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Some new maps of the Crab Nebula made with the One Mile radio telescope are described. The map of total intensity at 2700 MHz shows considerable fine structure, particularly in the center of the nebula. The total intensity at 5000 MHz shows more fine structure. (W.D.M.)

12963 RADIO OBSERVATIONS OF THE CRAB NEBULA PULSAR. Drake, F. D. (Cornell Univ., Ithaca, N. Y.). Int. Astron. Union Symp.; No. 46, 73-83(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The radio properties of the Crab Nebula pulsar are reviewed. The pulsar lies at the center of the Crab Nebula and has a period of 33 msec. Its increase in period with time releases an amount of energy equal in magnitude to the total radiated power. Instabilities in the period of the Crab pulsar have been discovered with time scales ranging from days to months. The length of the pulse increases at longer wavelengths due apparently to multipath propagation effects. A characteristic of the Crab pulsar is the great intensity of the occasional pulse. (auth)

12964 X-RAY OBSERVATIONS OF NP 0532. Rappaport, Saul (Massachusetts Inst. of Tech., Cambridge). Int. Astron. Union Symp.; No. 46, 84-6(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

From results of four sounding-rocket and two balloon flights, properties of the x-ray pulsations from NP 0532 are summarized. (W.D.M.)

12965 OPTICAL OBSERVATIONS OF THE CRAB PULSAR, AND SEARCHES FOR OTHER OPTICAL PULSARS. Kristian, Jerome (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Int. Astron. Union Symp.; No. 46, 87-90(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The optical properties of the Crab Nebula pulsar are reviewed. The Crab pulsar has a high degree of constancy at optical wave-

lengths. No time variations over short or long periods have been detected; the light curve is nearly the same in all colors. The intensity and color of the pulsar are V = 16.5, B − V = +0.5, U − B = −0.45, and V − R = −0.75. There is no precursor as found at radio wavelengths and the main pulse contains 65% of the total energy. No lines have been detected. Searches for other pulsars have been unsuccessful. (auth)

12966 RELATION OF THE LOW FREQUENCY SOURCE TO THE CRAB PULSAR. Lang, Kenneth R. (Cornell Univ., Ithaca, N. Y.). Int. Astron. Union Symp.; No. 46, 91-6(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The view that the compact low-frequency source and the pulsar NP 0532 are the same object is substantiated by an examination of the general properties of interstellar scattering. This scattering accounts for the observed angular size of the compact source, the observed pulse broadening of NP 0532. The continuum nature of the compact source, and the observed spectrum of both the pulsar and the compact source. (auth)

12967 INDIVIDUAL RADIO PULSES FROM NP 0531. Sutton, J. M. (National Radio Astronomy Observatory, Green Bank, W. Va. Cambridge Univ., Eng.); Staelin, D. H.; Price, R. M. Int. Astron. Union Symp.; No. 46, 97-102(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Observations with a swept frequency machine show that the shapes of individual pulses from NP 0531 are truncated exponentials with widths proportional to λ^{-4}, consistent with the broadening arising from scattering in the interstellar medium. A histogram of pulse intensity reveals two different populations. The very strong pulses are associated only with the main pulse and interpulse. (auth)

12968 PULSAR NP 0532: RECENT RESULTS ON STRONG PULSES OBTAINED AT ARECIBO. Heiles, Carl (Arecibo Observatory, Puerto Rico); Rankin, John M. Int. Astron. Union Symp.; No. 46, 103-9(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

New observations were made of strong pulses from NP 0532. Linear polarization was typically 25% and circular polarization was less than 10% but definitely not zero. A comparison of pulse shapes at 429.9 and 430.1 MHz showed significant differences in detailed structure and polarization. In another study, strong pulses at 318 and 111 MHz did not occur together, although a strong pulse at one frequency was accompanied by an above-average intensity at the other frequency. Similar behavior was found at 111 and 74 MHz. It was concluded that strong pulses do not have a smooth continuous frequency spectrum. (auth)

12969 RADIO OBSERVATIONS OF THE CRAB PULSAR AT 408, 240, AND 151 MHz. Schoenhardt, Rudolf E. (Univ. of Manchester, Jodrell Bank, Eng.). Int. Astron. Union Symp.; No. 46, 110-13(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The radio pulses from NP 0532 were observed at Jodrell Bank on several days in June, July, and August 1970 at frequencies of 408, 240, and 151 MHz. The integrated pulse shapes and the linear polarization of the average pulses were investigated. (W.D.M.)

12970 TIME VARIABILITY OF THE DISPERSION OF THE CRAB NEBULA PULSAR. Rankin, J. M. (Univ. of Iowa, Iowa City); Roberts, J. A. Int. Astron. Union Symp.; No. 46, 114-17 (1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The dispersion of the Crab pulsar was measured as a function of time from May 10, 1969 to July 24, 1970. Transient events occurred in the middle of June each year that coincided with the occultation of the pulsar by the solar corona. In addition, there were 2 or 3 distinct events that produced enhancements of several times 10^{16} electrons cm^{-2}; these were characterized by rise times of about 50 days and decay times several times longer. One event correlated with the frequency jump of the pulsar at the end of September 1969 and with the observation of optical activity in the nebula. A discussion is given of the interpretation of the variations in dispersion measure. (auth)

12971 FARADAY ROTATION OF THE CRAB PULSAR RADIATION. Manchester, R. N. (National Radio Astronomy Observatory, Green Bank, W. Va.). Int. Astron. Union Symp.; No. 46, 118(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

During April 1970, the 300-ft telescope of NRAO was used to determine the mean polarization of NP 0532 around 400 MHz. The observed variation of the position angle of the precursor with frequency was consistent with Faraday rotation of the plane of polarization with a rotation measure of -40.5 ± 4.5 rad/in^2. (W.D.M.)

12972 TIMING OF OPTICAL PULSES FROM THE CRAB NEBULA PULSAR. Boynton, P. E.; Groth, E. J.; Partridge, R. B.; Wilkinson, David T. (Princeton Univ., N. J.). Int. Astron. Union Symp.; No. 46, 119-24(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Timing the arrival of optical pulses from NP 0532 is a potentially important tool for studying the physics of this fascinating object. However, there are some difficulties in interpreting the data in terms of physical models. Some progress has been made on understanding the largest effect — the pulsar braking mechanism. The glitch of late September 1969 can be interpreted as the speedup, and subsequent relaxation, of the rotation of a neutron star crust. An alternate explanation is that of a planet in an eccentric orbit. Both models fit the rather meager data near the event. A small sinusoidal effect is indicated in a relatively quiet period of the data. (auth)

12973 TIMING OBSERVATIONS OF THE CRAB NEBULA PULSAR AT THE ARECIBO OBSERVATORY. Roberts, J. A.; Richards, D. W. (Arecibo Observatory, Puerto Rico). Int. Astron. Union Symp.; No. 46, 125-8(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Timing observations of the Crab pulsar were made between May 10, 1969 to July 3, 1970. Arrival times were corrected to the barycenter of the solar system; a further correction was made for the effect of dispersion. The only jump in period occurred in September 1969, although small irregularities in the period occurred at other times. A third-order polynomial fitted all the observed data to within ±0.15 pulse periods. (auth)

12974 SEARCH FOR VARIATIONS IN THE INTENSITY OF THE OPTICAL PULSES FROM NP 0532. Hegyi, D. (Goddard Inst. for Space Studies, New York); Novick, R.; Thaddeus, P. Int. Astron. Union Symp.; No. 46, 129-41(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

A search for short-time variability of NP 0532 using the 82- and 107-in. telescopes at McDonald Observatory is described. Observations were made of the mean intensity, the mean square of the intensity, and the mean autocorrelation function of the pulsar light. Limits were placed on the variability of the optical pulsar. (auth)

12975 RESULTS OF OPTICAL TIMING MEASUREMENTS OF THE CRAB NEBULA PULSAR. Papaliolios, C. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Univ., Cambridge, Mass.); Carleton, N. P.; Horowitz, P. Int. Astron. Union Symp.; No. 46, 142-50(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Absolute time-of-arrival measurements were made of the optical pulses from the Crab pulsar between September 1969 and April 1970; they were corrected to the solar system barycenter. The fit to the timing data indicates that the slowdown is due to magnetic dipole radiation, but there are significant deviations, indicating the presence of small fluctuations and major jumps. There is no evidence of the quasi-sinusoidal behavior reported by Arecibo. These measurements allowed an integrated light curve to be constructed with high precision. (auth)

12976 PHOTOMETRY AND POLARIMETRY OF THE CRAB PULSAR. Visvanathan, N. (Harvard Coll. Observatory, Cambridge, Mass.). Int. Astron. Union Symp.; No. 46, 152-6(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Observational results are presented for the pulse component, the nebular component, and the wisp component of the Crab Nebula. The pulsar polarization is separated from the background nebular polarization. The relation between the pulsar and the adjacent nebula is discussed. (auth)

12977 MEASUREMENT OF THE CIRCULAR POLARIZATION OF PULSAR NP 0532. Angel, J. R. P. (Columbia Univ., New York); Hegyi, D.; Landstreet, J. D. Int. Astron. Union Symp.; No. 46, 157-9(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The polarizer is briefly described. The polarization of the whole pulse is not significantly different from zero ($-0.15 \pm 0.70\%$). Polarization measurements of the leading edge and trailing edge of the main pulse are also given. (auth)

12978 SEARCH FOR PULSED HIGH-ENERGY GAMMA RADIATION FROM NP 0532. Fazio, G.; Hearn, D.; Helmken, H.; (and others) (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Int. Astron. Union Symp.; No. 46, 160-1(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

During winter 1969 the 10-m optical reflector at Mt. Hopkins, Arizona, was used to search for periodic gamma-ray emission above 10^{11} eV from Np 0532. Based on predicted optical period and phase, approximately 57 h of data were summed together. No evidence of pulsed radiation was found. (auth)

12979 GALACTIC POPULATION OF PULSARS. Large, M. I. (Univ. of Manchester, Jodrell Bank, Eng.). Int. Astron. Union Symp.; No. 46, 165-81(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The distribution of pulsars in the Galaxy was examined and compared with the distribution of supernova remnants. The dispersion measure was used as a distance indicator to obtain the distribution in luminosity, z distance, and period of the pulsars. The z-distance distribution was similar within the uncertainties to that of the supernova remnants. An estimate of the total number of pulsars in the Galaxy with a peak luminosity ≥ 1 fu(dm)^2 gave 5×10^5 within a factor of 10. The data were consistent with the hypothesis that pulsars are formed at the same rate as supernovae, if the pulsars are assumed to have a timescale of 10^7 yr. (auth)

12980 COMPARATIVE PROPERTIES OF THE PULSARS. Lyne, A. G. (Univ. of Manchester, Jodrell Bank, Eng.). Int. Astron. Union Symp.; No. 46, 182-94(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The outstanding characteristics of the pulsars are reviewed and, in particular, the properties of the Crab Nebula pulsar are compared with those of the other pulsars. The Crab pulsar is unique in that it has a remarkably short period, emission outside the radio band, some strange amplitude variations, and an abnormally large interpulse. (auth)

12981 POLARIZATION OF PULSARS. Moffet, Alan T. (California Inst. of Tech., Pasadena). Int. Astron. Union Symp.; No. 46, 195-9(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Polarization properties of pulsars were surveyed. Many pulsars, although showing pulse-to-pulse variations in polarization, have a stable mean polarization characteristic. Several pulsars like 0833−45 show changes in the position angle of linear polarization across the pulse which can be interpreted as due to the changing direction of the magnetic field as envisaged in the oblique magnetic dipole model of pulsars. Faraday rotation measurements, when taken with dispersion measures, yield values for the interstellar magnetic field of several microgauss. (auth)

12982 OBSERVATIONS OF PULSAR SPECTRA. Ewing, M. S.; Batchelor, R. A.; Friefeld, R.; Price, R. M.; Staelin, D. H. (Massachusetts Inst. of Tech., Cambridge). Int. Astron. Union Symp.; No. 46, 200-5(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The observed width of spectral features in CP 0328, CP 0834, and CP 1919 are approximately proportional to the fourth power of frequency, thus supporting the hypothesis that the slow spectral variations of these pulsars are due to interstellar scintillation. The spectral features in CP 0834, CP 1133, and CP 1919 are observed to drift systematically at rates compatible with a simple interstellar scintillation model. Pulsar velocities of ~100 km sec^{-1} are inferred from these spectral drift rates. (auth)

12983 POLARIZATION MEASUREMENTS OF OTHER PULSARS AT JODRELL BANK. Graham, D. A. (Univ. of Manchester, Jodrell Bank, Eng.). Int. Astron. Union Symp.; No. 46, 206-8(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The polarization properties of a number of pulsars have been studied at Jodrell Bank, using the 76-in. Mark I radiotelescope. Included in the study were CP 0328, PSR 2045, PSR 1929, AP 1237, CP 0950, NP 0532, and CP 1133. (W.D.M.)

12984 CRAB PULSAR RADIATION CHARACTERISTICS. Manchester, R. N. (National Radio Astronomy Observatory, Green Bank, W. Va.). Int. Astron. Union Symp.; No. 46, 209-10(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Phenomena observed in PSR 1237 + 45 that may be related to the erratic amplitude behavior of the Crab pulsar main pulse are described, and the main pulse profile for this pulsar is shown. (W.D.M.)

12985 TIMING OF THE PULSAR NP 0527. Richards, D. W.; Roberts, J. A. (Cornell-Sydney Univ. Astronomy Center, Arecibo, Puerto Rico). Int. Astron. Union Symp.; No. 46, 211-16(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Timing measurements were made of NP 0527 in order to examine its physical relationship with NP 0532. Eighteen months of timing data were used to obtain an accurate frequency, rate of change of frequency, and position. The calculated "slowdown age" of Np 0527 is 3.0×10^6 years, which rules out an origin in the supernova explosion of 1054 A.D. The upper limit of its transverse velocity is 0.046c, which is significantly less than the value necessary if it has a common origin with NP 0532. (auth)

12986 INTERSTELLAR SCATTERING AND THE PULSE FROM THE VELA PULSAR. Komesaroff, M. M. (CSIRO, Sydney); Hamilton, P. A.; Ables, J. G. Int. Astron. Union Symp.; No. 46, 217-21(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Measurements of PSR 0833−45 were made at wavelengths of 21, 48, 73, and 100 cm. Pulse broadening proportional to about the fourth power of the wavelength was found, consistent with multipath scattering in the interstellar medium. It is further concluded that the rotation measure was constant at 33.2 rad m^{-2} across this wavelength range, supporting the conclusion that the radiation originates in the vicinity of a magnetic pole. (auth)

12987 SEARCHES FOR OPTICAL PULSARS. Willstrop, R. V. (Observatories, Cambridge, Eng.). Int. Astron. Union Symp.; No. 46, 222-8(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The limitations of searches for pulsed optical radiation from pulsars and other objects are considered for the two cases: (a) when the period is known from radio observations, and (b) when the period is unknown. Results of searches by the author and by others are summarized. (auth)

12988 RESULTS OF A SEARCH FOR VISIBLE PULSARS. Horowitz, P. (Harvard Univ., Cambridge, Mass.); Papaliolios, C.; Carleton, N. P. Int. Astron. Union Symp.; No. 46, 229-33(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

A number of interesting celestial objects, including x-ray sources, nova and supernova remnants, white dwarfs, infrared stars, planetary nebulae, radio sources, and some other peculiar nebulosities were searched with Fourier and correlation techniques for the presence of optical pulsars. The sensitivity of these methods was established with synthetic data and by observations of the Crab Nebula pulsar, the minimum detectable signal (5 standard deviations above noise) being approximately 20th visual magnitude, time averaged. To this limit no new pulsars were found over the range of periods searched—from 5 msec to several seconds. (auth)

12989 MAGNETISM IN WHITE DWARFS. Landstreet, J. D. (Columbia Univ., New York); Angel, J. R. P. Int. Astron. Union Symp.; No. 46, 234-6(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Searches were made for the normal and quadratic Zeeman

effect and broad-band circular polarization in white-dwarf stars. A positive effect was found in Grw + 70°8247 whose continuum shows both linear and circular polarization. (auth)

12990 COMMENTS ON SUPERNOVA REMNANTS AND ANCIENT NOVAE. Minkowski, R. (Univ. of California, Berkeley). Int. Astron. Union Symp.; No. 46, 241-7(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The low expansion velocity of the Crab Nebula proves conclusively that the supernova of +1054 was not type I. Only five supernova remnants found in radio surveys are connected with ancient novae, +185, +1006, +1054, +1572, and +1604. This corresponds to reasonable expectation. Most of the objects in historical records were comets, the remainder mostly ordinary novae. Most radio remnants are too old, some too heavily obscured to be found in historical records. (auth)

12991 RADIO EMISSION FROM SUPERNOVA REMNANTS. Milne, D. K. (CSIRO, Sydney). Int. Astron. Union Symp.; No. 46, 248-62(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Observations of the radio emission from supernova remnants are reviewed with emphasis on the dissimilarity between the Crab Nebula and the other remnants. From this it is concluded that there may be several nonthermal sources in the Galaxy with the same centrally filled structure as the Crab. These are, however, more evolved, and clearly there is no other source of the same age and type as the Crab Nebula. (auth)

12992 CASSIOPEIA A: THE YOUNGEST KNOWN GALACTIC SUPERNOVA REMNANT. van den Bergh, Sidney (Univ. of Toronto). Int. Astron. Union Symp.; No. 46, 263-7(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Proper motion observations show that the explosion of the Cas A supernova took place in AD 1667 ± 8(me). Individual moving knots have lifetimes ~10 yr. In these fast-moving knots, oxygen and argon are overabundant by a factor of at least seventy with respect to hydrogen and nitrogen. Nitrogen is found to be overabundant in quasi-stationary flocculi. This suggests that these flocculi were formed from material that was ejected from the outer layers of the pre-supernova before its explosion in AD 1667. (auth)

12993 SECULAR BEHAVIOR OF X-RAY AND RADIO EMISSION FROM SUPERNOVA REMNANTS. Tucker, Wallace H. (American Science and Engineering, Cambridge, Mass.). Int. Astron. Union Symp.; No. 46, 268-72(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Continuous injection models for the secular behavior of the radio and x-ray emission from supernova remnants were examined and compared with the observations. Among other things, it was concluded that (1) continuous injection probably occurs for at least 10 yr in every case and about 1000 yr in most supernova remnants, in which case the supernova remnants 3C 392, W28, Pup A, and IC443 should produce 1 to 10-keV x-ray fluxes $\approx 10^{-10}$ ergs/cm^2-sec, and (2) the x-ray sources in the Crab Nebula, Cas A and Tycho, can be explained in terms of a model wherein continuous injection occurs for 300 yr for the Crab Nebula, much less than 250 yr for Cas A, and much longer than 400 yr for Tycho. Finally, it is shown that if Tycho and Cas A contain an x-ray star such as NP 0532, it is quite possible that the x-ray emission from those sources is predominantly due to the x-ray star. (auth)

12994 PULSARS AND CLOSE BINARY SYSTEMS. Trimble, Virginia; Rees, Martin (Inst. of Theoretical Astronomy, Cambridge, Eng.). Int. Astron. Union Symp.; No. 46, 273-8(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

It is first considered what must happen if pulsars (i.e., neutron stars) are formed in close binary systems and whether the resulting orbital motion and mass transfer should be observable. As this set of alternatives seems unlikely, there follow suggestions of how one might prevent the formation of neutron stars in close binaries. Finally, it is shown that "runaway" pulsars with velocities larger than about 15 km/sec cannot be produced by isotropic supernova explosions within close binaries, and an alternative explanation is suggested for the observed correlation of periods of pulsars with their distances from the galactic plane. (auth)

12995 PLASMA INTERACTIONS IN THE CRAB NEBULA. Kahn, F. D. (Univ. of Manchester, Eng.). Int. Astron. Union Symp.; No. 46, 281-91(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Alfvén waves can be carried by the thermal plasma in the Crab Nebula. Each such wave perturbs the relativistic plasma present; in particular, it strongly affects those particles that are in resonance with it. For a wave traveling parallel to the magnetic field the resonances are quite simple, but a wave traveling obliquely can give rise to multiple resonances, and can therefore couple together particles with quite different energies. It is shown that the interaction with the relativistic plasma leads to an amplification of the Alfvén waves when the mean velocity of relativistic plasma relative to the thermal plasma exceeds the Alfvén speed. The rise time for the instability is quite short, and the waves, once excited, are highly effective in redistributing the directions of motion of the relativistic particles. The relativistic plasma, therefore, cannot stream freely through the thermal plasma. On the other hand the disturbances will never quite die out in the Crab Nebula as long as the Crab pulsar keeps injecting fresh plasma, and thus keeps producing new inhomogeneities in the relativistic plasma density. (auth)

12996 RADIO POLARIZATION OF THE CRAB NEBULA. Conway, R. G. (Univ. of Manchester, Jodrell Bank, Eng.). Int. Astron. Union Symp.; No. 46, 292-5(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Optical and radio measurements of polarization can be combined to find the configuration of the magnetic field throughout the Crab Nebula. The component in the line of sight is found from the radio rotation measure. New measurements of polarization at 11 cm with a resolution of 7″ × 14″ were combined with previous results to show that the rotation measure is fairly uniform and near −25 rad m^{-2} near the center, but that it becomes irregular near the edges. It rises to 300 rad m^{-2} in the filaments, possibly indicating a concentration of electrons about 10 to 100 cm^{-3}. (auth)

12997 TRANSFER OF ENERGY TO THE CRAB NEBULA FOLLOWING THE SPIN-UP OF THE PULSAR. Melrose, D. B. (Australian National Univ., Canberra). Int. Astron. Union Symp.; No. 46, 296-307(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Observed enhanced activity in the central region of the Crab Nebula following the spinup of the pulsar is discussed from the point of view of the transfer of energy to relativistic electrons. It is argued that a rapid deposition of energy associated with the spinup of the pulsar causes a radial energy flux that becomes a flux in hydromagnetic activity at about the regions where enhanced synchrotron emission is observed. It is shown that such hydromagnetic activity is rapidly damped by the relativistic electrons with energy being transferred to the relativistic electrons. This acceleration can account for the short synchrotron half-lives observed. The model predicts highly enhanced x-ray emission from the central region of the Nebula following a spinup. (auth)

12998 RADIATIVE IONIZATION OF THE FILAMENTS IN THE CRAB NEBULA. Davidson, Kris (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.); Tucker, Wallace H. Int. Astron. Union Symp.; No. 46, 308-13(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

An attempt is made to explain the observed excitation conditions in the filamentary system of the Crab Nebula in terms of ionization and heating by high-frequency radiation. It was found that it is possible to reasonably fit most of the observed lines by assuming either (1) an ultraviolet continuum that smoothly joins the optical and x-ray data and a gas composition in which the number densities of hydrogen and helium are equal, (2) a spectrum that drops off about as steeply as ν^{-2} and therefore does not smoothly fit the x-ray spectrum, or (3) an ultraviolet continuum that smoothly joins the optical and x-ray data plus strong emission-line features near 20 eV. A uv continuum that is much larger than in these models results in too much ionization in the filaments. The calculations suggest that most of the filaments consist of outer ionized regions with cores of neutral gas, so that the mass of the filamentary shell may be considerably larger than the 1.45 $M_\odot$ required to explain the emission-line intensities. (auth)

12999 SYNCHROTRON RADIATION IN HIGH MAGNETIC FIELDS. Falla, D. F.; Evans, A. (University Coll. of Wales, Aberystwyth, Eng.). Int. Astron. Union Symp.; No. 46, 314-20 (1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

It is suggested that if there exist within the Crab Nebula localized condensations of material containing high magnetic fields, (≫1 G), the rapidly evolving synchrotron radiation power spectrum emitted by a single electron can give a radiation continuum with a spectral index having a unique value similar to that observed in the optical and low-energy x-ray regions. One implication of this result is that a simple comparison between the observed fluxes of optical and gamma radiation emitted by the Nebula is no longer meaningful, so that one cannot draw any immediate conclusion regarding the fundamental mechanism of electron and gamma-ray production. (auth)

13000 PHYSICS OF THE NEUTRON STAR. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Inst. for Space Studies, New York). Int. Astron. Union Symp.; No. 46, 323-33(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Some characteristics of neutron-star models are described. These include: the physics of the crystalline crust, the superfluid properties of the neutrons and protons, and the presence of rotational vortices in these superfluids. The possible relationship of some of these properties to the behavior of the Crab Nebula pulsar is described. (auth)

13001 GENERAL RELATIVISTIC THEORY OF ROTATING NEUTRON STARS: A REVIEW. Cohen, Jeffrey M. (Inst. for Advanced Study, Princeton, N. J.). Int. Astron. Union Symp.; No. 46, 334-40(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

A simple method for treating rotating neutron stars, which assumes only slow rotation, is valid even for strong gravitational fields. It allows a fully relativistic treatment of rotating stellar models, and has been applied to such problems by various authors. (W.D.M.)

13002 DYNAMICAL STABILITY OF NEUTRON STARS. Chanmugam, G.; Gabriel, M. (Univ., Liege). Int. Astron. Union Symp.; No. 46, 341-5(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The Nemeth–Sprung equation of state is modified and used to obtain neutron star models. Contrary to the results of some authors, it is found that neutron stars with central densities $\lesssim 10^{14}$ g cm^{-3} are dynamically stable. It is suggested that some pulsars may belong to this category of stars. (auth)

13003 MODELS OF ROTATING NEUTRON STARS IN GENERAL RELATIVITY. Bonazzola, S. (Observatoire de Paris, Meudon, France); Maschio, G. Int. Astron. Union Symp.; No. 46, 346-51(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

A numerical method of integration of Einstein's equations coupled with the hydrodynamic equations for a perfect fluid is described; some preliminary results are given. It is pointed out that the analogous problem was considered by Ostriker and Mark (1968) in the Newtonian case; by Thorne (1969) in general relativity in the weak angular velocity approximation; and by Barden and Wagoner (1969) for disk configurations in the pressure-vanishing case. (auth)

13004 EFFECTS OF NUCLEAR FORCES ON THE MAXIMUM MASS LIMIT OF NEUTRON STARS. Tsuruta, Sachiko (Goddard Space Flight Center, Greenbelt, Md.). Int. Astron. Union Symp.; No. 46, 352-5(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The original models of neutron stars must be improved by including effects of nuclear interactions. The models reached by various groups are compared, and an improved model by the Kyoto group is presented. The maximum mass varies between 0.2 and 3 $M_\odot$ in the various models. The V_γ model is recommended for use in the absence of further information on the equation of state at high densities. (auth)

13005 NUCLEAR FORCES IN HIGH DENSITY MATTER. McNaughton, M. R. (Enrico Fermi Inst., Chicago). Int. Astron. Union Symp.; No. 46, 356-63(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The conditions for superfluidity or ferromagnetism in neutron stars are presented and discussed (but not derived). It is suggested that present estimates relating to these are in error and that the predictions made contradict at least one of three sets of nuclear physics data cited in the text. This is due to neglecting the action of the exclusion principle. A comparatively simple method for calculating the strength of nuclear forces in the presence of many-body effects is outlined. Some preliminary results are presented, together with projected future developments. (auth)

13006 PERIODICITY AND LUMINOSITY OF THE PULSAR MODEL OF QUASARS. Fowler, William A. (Inst. of Theoretical Astronomy, Cambridge, Eng. California Inst. of Tech., Pasadena). Int. Astron. Union Symp.; No. 46, 364-77(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The diagnosis of pulsar-like symptoms in the quasar 3C 345 has renewed interest in differentially rotating supermassive stars (SMS). Quasi-periodic behavior follows from differential rotation. In reviewing early work on this quasar model, it is found that SMS models with rotational periods of the order of a few hundred days, and with pulsation periods approximately one-quarter as long, can supply thermal and magnetic dipole radiation of the order of 10^{48} erg sec^{-1} for somewhat more than 10^6 yr. The surface field required for the magnetic dipole radiation is approximately 10^3 G. The SMS mass taken as typical in the calculations is 3×10^9 $M_\odot$. (auth)

13007 MULTIPLE PULSAR EJECTION IN SUPERNOVA EVENTS. Michel, F. Curtis (Inst. of Theoretical Astronomy, Cambridge, Eng.). Int. Astron. Union Symp.; No. 46, 378-81 (1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Fragmentation in the collapse of a supernova core, followed by energy loss in neutron star formation, is shown to lead to disruption of the resulting system. The elements of the system, some of which should be pulsars, can attain velocities of the order of 10^3 km/sec if currently quoted parameters are correct. (auth)

13008 EMISSION OF GRAVITATIONAL WAVES FROM THE PULSAR. Ruffini, R. (Inst. for Advance Study, Princeton, N. J.). Int. Astron. Union Symp.; No. 46, 382-3(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

A brief survey of present experimental evidence for the existence of gravitational waves is given, and the possibility that the shapes of neutron stars might depart from rotational symmetry, leading to the emission of gravitational waves, is discussed. (W.D.M.)

13009 RELATIONSHIP BETWEEN PULSAR AND NEBULA. Woltjer, L. (Columbia Univ., New York). Int. Astron. Union Symp.; No. 46, 389-91(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The magnetic field and the relativistic electrons in the Crab Nebula cannot have originated at the time of the supernova explosion. The energy density in the magnetic field is so large that it must have been generated using the energy supply in the pulsar. The energies of the electrons are so high, and their lifetimes correspondingly are so short, that they must have been accelerated, again using the pulsar energy. The efficiency of these processes must be high, but there is an adequate energy supply. (auth)

13010 MAGNETIC DIPOLE MODEL FOR THE CRAB EXPLOSION. Ostriker, J. P. (Princeton Univ., N. J.). Int. Astron. Union Symp.; No. 46, 392-3(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

It is suggested that the main features of the Crab Nebula, in particular the value of its magnetic field and the energy of the particles, could be derived very simply and directly from the known characteristics of the pulsar. The link is through the radiation from a spinning dipole. (W.D.M.)

13011 PHYSICAL PROCESSES AND PARAMETERS IN THE MAGNETOSPHERE OF NP 0532. Pacini, F. (Cornell Univ., Ithaca, N. Y.). Int. Astron. Union Symp.; No. 46, 394-406(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The Crab Nebula pulsar conforms to the model of a rotating magnetized neutron star in the rate of energy generation and the exponent of the rotation law. It is suggested that the main

pulse is due to electrons and the precursor to protons. Both must radiate in coherent bunches. Optical and x-ray radiation is by the synchrotron process. The wisps observed in the Nebula may represent the release of an instability storing about 10^{43} erg and 10^{47-48} particles. Some considerations are made about the general relation between supernova remnants and rotating neutron stars. (auth)

13012 NONTHERMAL CONTINUUM FROM THE CRAB NEBULA: THE SYNCHRO-COMPTON INTERPRETATION. Rees, M. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Int. Astron. Union Symp.; No. 46, 407-13(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The continuum emission from the Crab Nebula may be radiation from relativistic electrons moving in the electromagnetic wave field radiated by the rotating magnetic dipole of the pulsar. This radiation, called synchro–Compton radiation, would show ordering over the whole Nebula, as is observed in measurements of polarization. The properties of this radiation are described. (auth)

13013 MASER THEORY OF PULSAR RADIATION. Chiu, Hong-yee (Goddard Space Flight Center, New York). Int. Astron. Union Symp.; No. 46, 414-28(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

An account of a theory of pulsar radio emission is presented. The emission mechanism is via a maser amplification process. This theory avoids the difficulty of coherent plasma emission—that the bandwidth of radiation must be less than $\frac{1}{2}\lambda$. The high-brightness radio temperature and the insensitivity of pulsar radio flux to pulsar periods can be easily accounted for. (auth)

13014 RADIATION MECHANISM IN PULSARS. Smith, F. G. (Univ. of Manchester, Jodrell Bank, Eng.). Int. Astron. Union Symp.; No. 46, 431-40(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The properties of the radio pulses from pulsars are described. The formation of pulses seems to be a geometric phenomenon, for which the beaming due to relativistic motion of the source is the only candidate at present. Values of the volume emissivity and surface flux density indicate that all the particles near the source must have relativistic energies. (auth)

13015 LOW-MODE COHERENT SYNCHROTRON RADIATION AND PULSAR MODELS. Eastlund, Bernard J. (Atomic Energy Commission, Washington, D. C.). Int. Astron. Union Symp.; No. 46, 443-8(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The radio pulses from pulsars are considered to be formed from the beamed radiation from relativistic electrons. This radiation is in low-order harmonics of the gyrofrequency, giving pulse shapes and polarizations that agree with observation. A possible connection between the shapes of radio pulses and the emission of optical pulses, via the electron energy, leads to a suggested means of searching for visible pulsars with improved sensitivity. (auth)

13016 RADIATION FROM PULSARS. Lerche, I. (Univ. of Chicago). Int. Astron. Union Symp.; No. 46, 449-54(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

It is suggested that an oscillating interface, carrying a steady current between a rotating, radiating, magnetic dipole and an external plasma, is the source of pulsar radiation produced over a broad band of high frequencies (10^8 to 10^{18} Hz). The efficiency of the radiation mechanism is so high that the oscillation energy goes mainly into radiation in each cycle of the oscillation. (auth)

13017 RADIATION BEAMING IN PULSARS. Canuto, V. (Goddard Space Flight Center, New York). Int. Astron. Union Symp.; No. 46, 455-6(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

It is usually considered that the beaming of the radiation coming from a pulsar has to be strictly connected to the mechanism producing the radiation. It is shown that, even when the emitting mechanism gives rise to an isotropically disturbed radiation, the presence of a strong magnetic field will automatically beam the radiation preferentially along the magnetic field line rather than in any other direction. (W.D.M.)

13018 LOW-FREQUENCY CUTOFFS IN SYNCHROTRON SPECTRA AND THE OPTICAL SPECTRUM OF NP 0532. O'Dell, Stephen L.; Sartori, L. (Massachusetts Inst. of Tech., Cambridge). Int. Astron. Union Symp.; No. 46, 457-9(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

The existence of a natural low-frequency cutoff in the spectrum of a synchrotron source is pointed out. The turnover frequency is $eB/mc(\sin\Psi)$, where Ψ is the pitch angle for the electron motion. The spectrum below the turnover goes as ν^n, where n is the index in the electron energy distribution. For the Crab pulsar, a model with $B \sim 10^6$ to 10^7 G and $(\sin\Psi) \sim 10^{-3}$ to 10^{-2} provides a plausible explanation for the turnover observed in the infrared. (auth)

13019 PULSAR (AND X-STAR) EMISSION FROM THE MAGNETOSPHERE OF A COLLAPSED STAR. Coppi, Bruno (Massachusetts Inst. of Tech., Cambridge); Ferrari, Attilio. Int. Astron. Union Symp.; No. 46, 460-70(1971).

From Symposium on the Crab Nebula; Jodrell Bank, England (5 Aug 1970).

Nonthermal plasma mechanisms are proposed to account for the most evident physical characteristics of pulsar emission, including the production of x and γ rays and the acceleration of high-energy particles. Special reference to the Crab Nebula pulsar (NP 0532) is made, and an application of the same model to other nonthermal x-ray sources is suggested. (auth)

13020 POSSIBLE EVIDENCE FOR PULSED 10^{12}-eV GAMMA RAYS FROM NP 0532. Grindlay, J. E. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Nature (London) Phys. Sci.; 234: No. 51, 153-5(20 Dec 1971).

It is stated that experimental and theoretical evidence was found in studies of extensive air showers suggesting that showers initiated by a primary γ ray may be distinguished, with a probability of >70%, from those initiated by cosmic rays of $\sim 10^{12}$ eV. This distinction is made possible by identification of a unique feature of the EAS Cherenkov radiation attributable to the penetrating muon component and only expected for EAS initiated by cosmic rays. The sensitivity of experiments used to search for point sources of primary γ rays $\sim 10^{12}$ eV has also been increased by improved angular resolution made possible with new methods of Cherenkov detection of EAS. A new search is described for primary γ rays from the direction of the Crab Nebula, conducted at the Mt. Hopkins Observatory in Jan. 1971. A search was made both for a continuous flux from the Nebula and a pulsed flux from NP 0532, using an array of four searchlight mirrors over a 70-m baseline. Individual showers were identified as cosmic-ray-initiated events if Cherenkov light from their penetrating muon core was also detected. Showers detectable only at their maxima were considered γ events, that is possibly γ-ray-initiated. From the data obtained the energy at the Earth associated with pulsed γ rays above 6×10^{11} eV is found to be $\gtrsim 10$ eV/cm^2, or ~ 0.01 of the energy associated with x rays, and the total luminosity of NP 0532 above 1 keV would then be $\sim 3.6 \times 10^{36}$ ergs/sec or about 0.01 of the energy input to the Crab Nebula. Analysis of all scans, without regard to pulsar timing, gave an upper limit of $< 3.5 \times 10^{-11}$ photon/cm^2/sec for a continuous γ-ray flux from the Crab. Pulsed γ rays at energies $> 6 \times 10^{11}$ eV from NP 0532 are suggested. (UK)

13021 ANGULAR DISTRIBUTION OF QUASI-STELLAR OBJECTS. Wills, D. (Univ. of Texas, Austin). Nature (London) Phys. Sci.; 234: No. 52, 168-72(27 Dec 1971).

It is stated that an examination of the distribution on the sky of quasi-stellar objects identified with 4C radio sources showed no significant departures from a uniform distribution of redshift, apparent magnitude, or total number as a function of position on the sky. (auth)

13022 CEN XR-3: A NEUTRON STAR YOUNGER THAN THE CRAB. Henriksen, R. N.; Feldman, P. A.; Chau, W. Y. (Queen's Univ., Kingston, Ont.). Nature (London); 234: No. 5330, 450-3(24 Dec 1971).

A model for the pulsed x-ray source Cen XR-3 was constructed, based on studies of wobbling, young, evolving neutron stars that are generating heat in their crusts by the conversion of rotational energy through precession-induced cyclic strain. The observational features can be understood if the observed period is interpreted as the free nutation period. It is predicted that the actual rotational period is ~8 ms and the slowdown rate $\sim 8 \times 10^{-13}$ s/s. (auth)

13023 NEW LOOK AT THE LABORATORY MICROWAVE SPECTRUM OF CYANOACETYLENE. Johnson, Donald R.; Lovas, Frank (National Bureau of Standards, Washington, D. C.). Astrophys. J.; 169: No. 3, 617-19(1 Nov 1971).

Laboratory measurements were made on several rotational transitions in cyanoacetylene with potential application to radio astronomy. Observations of $J = 1 \leftarrow 0$ and $J = 2 \leftarrow 1$ rotational transitions are reported for the isotopic species $H^{12}C^{12}C^{12}C^{14}N$, $H^{13}C^{12}C^{12}C^{14}N$, and $H^{12}C^{12}C^{12}C^{15}N$. Measurement errors and resolution of hyperfine structure are discussed in some detail. (auth)

Solar Phenomena

Refer also to abstracts 12127, 13178, 13192, and 13644.

13024 COMPTON BACKSCATTERING OF SOLAR X-RAY EMISSION. Tomblin, Fred F. (Bellcomm, Inc., Washington, D. C.). Astrophys. J.; 171: No. 2, 377-89(15 Jan 1972).

Compton backscattering of solar-flare emission, $\lambda < 2$ Å, appears to have several interesting effects when x-ray spectra are considered in detail. Line emission generates secondary spectra shifted up to ~0.08 Å, thereby broadening the long-wavelength wing. The iron lines at 1.9 Å are discussed in detail, and the observed spectra obtained between 1.88 and 1.92 Å are shown to be significantly affected by Compton backscattering for flares occurring on the solar disk. The rapid decrease in the photoelectric cross section causes the Compton backscattering contribution to increase from 5 to 50% over the region from 2.5 to 0.3 Å. This implies substantial corrections to emission measures obtained from high-energy solar events. Flare temperatures inferred from the corrected continuum shape may be reduced as much as 20%. The iron abundance in the photosphere deduced from the iron Kα fluorescence line at 1.932 Å does not appear to be sufficient to generate an observable change in the Compton reflectivity at the iron K-shell edge at 1.74 Å. (auth)

13025 PRECISE DETERMINATIONS OF THE MAGNETIC VECTOR IN SUNSPOTS. Adam, M. G. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc., 155: No. 2, 169-83(1971).

The reality of some physical effects suggested for sunspot magnetic fields is still doubtful because of the low, or unknown, precision of the observations from which the effects are deduced. For the determination of magnetic field configurations Treanor's method, involving micrometer position measurements, is considerably more sensitive and more powerful than the usual methods depending upon line-intensity measurements, but its full potential accuracy has not hitherto been achieved. Several modifications have now been made in the techniques of Treanor's method in order to obtain greater precision. The chief change is to convert the polarization-state analyzer into a simple spectroscope slit device: this entails an extra mirror reflection before the analysis is made, and the corrections for instrumental polarization were accordingly reconsidered. The theory has now been extended to include the dependence of the corrections upon absorption line strength. The revised procedure was used for magnetic field determinations across a medium-sized spot, and the consistency of the results for Fe I lines indicates that the direction of the magnetic vector is now obtained with a mean precision of 2 to 3°. The spot magnetic field, when the observations have this degree of certainty, is free from the anomalous effects suggested by earlier work. (auth)

13026 PRIMARY SOLAR REACTION DEPENDENCE ON DEUTERON STRUCTURE. Brolley, John E. (Los Alamos Scientific Lab., N. Mex.). Solar Phys.; 20: No. 2, 249-56(Nov 1971).

The energy dependence of the process $p + p \rightarrow D + e^+ + \nu$ was investigated as a function of the % D state. The pp wavefunction was generated from a Schrödinger equation utilizing a velocity-dependent potential, containing the effect of vacuum polarization, which was fitted to the most recent pp phases. The present likely uncertainty in % D state implies 1½% uncertainty in the reaction rate. The calculation of $\Lambda^2(0)$ was 4% less than a previous result. New values of S(0), incorporating recent ft values, were obtained. (auth)

13027 EFFECTS OF ACTIVE SOLAR REGIONS ON THE GALACTIC COSMIC-RAY INTENSITY. Antonucci, E.; Cini Castagnoli, G.; Dodero, M. A. (CNR, Turin. Univ., Turin). Solar Phys.; 20: No. 2, 497-506(Nov 1971).

During the year 1969 two long-lived centers were active on the Sun at Carrington longitudes $50° < L < 100°$ and $250° < L 300°$. About 80% of the flares of importance ≥1B, produced during this period, originated in these zones. The solar modulation of galactic cosmic-ray intensity during 1969 was dominated by effects resulting from the activity in the two zones. In fact all the decreases can be related to the passage at the central meridian of the active centers. Persistence of the effects connected to solar regions is found also during rotations in which they do not produce flares in front of the Earth. Seventeen among the twenty-six intensity decreases, observed during this period, can also be correlated to individual flares belonging to the region at central meridian (longitudes ±40° with respect to the CM). The data suggest that two phenomena are operative to produce decreases of the cosmic-ray flux: the passage of the interplanetary corotating stream associated with the active region near the central meridian and the blast wave produced by the flares in front of the Earth. (auth)

13028 FREUNDLICH RED SHIFT. Gasanalizade, A. G. (Astrophysical Observatory, Baku). Solar Phys.; 20: No. 2, 507-12(Nov 1971).

The Freundlich red shift of wavelengths in the solar spectrum is discussed. Born's approach on the photon–photon interaction is used in conjunction with Melvin's recalculation of Freundlich's universal constant in order to derive the cross section for scattering in the solar atmosphere. The new cross section appears to be $\langle \sigma_\odot \rangle = 1.58 \times 10^{-18}$ cm^2, which is about one thousand times Born's estimate for the effective cross section. However, a modified value of the constant $\langle \sigma_\odot \rangle$ is in a good agreement with the one obtained by Ter Haar by scattering process methods, which leads to 10^{-18} cm^2 for the photon–photon interaction cross section of the solar atmosphere. A new expression for Freundlich's red-shift formula is obtained. Some numerical examples are given and some interesting aspects of Freundlich's parameters are discussed. (auth)

13029 INTERFERENCE IN SOLAR OSCILLATIONS. Reif, R. J. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.); Musman, Steven. Solar Phys.; 20: No. 2, 257-63(Nov 1971).

Magnetograph observations of the 5-min oscillations were analyzed, and it was found that most of the oscillatory power is concentrated in space and frequency. Interference effects where these concentrations overlap can explain some of the variations in amplitude of the oscillation. (auth)

13030 USE OF THE GOLDBERG–UNNO METHOD FOR THE INVESTIGATION OF SMALL-SCALE PHOTOSPHERE MOTIONS. Gurtovenko, E.; Troyan, V. (Main Astronomical Observatory, Kiev). Solar Phys.; 20: No. 2, 264-74(Nov 1971).

The Goldberg–Unno method is analyzed. Accounting for the instrumental profile correction reduces the derived microturbulent velocities only slightly. A similar effect may be caused by an unresolved macroturbulence. The method of accounting for the damping effect is considered. The correction for the influence of the damping effect does not change substantially the general trend of the variation of ξ_t with τ_0. The microturbulent velocity ξ_t is reduced appreciably. An attempt to analyze the microturbulent velocities by the Goldberg–Unno method under deviation from LTE is made. The main conclusion is that the Goldberg–Unno method, especially in its modified form, is valid and useful. (auth)

13031 MEASUREMENT OF THE NONTHERMAL VELOCITY IN THE LOW CHROMOSPHERE. Canfield, Richard C. (Sacramento Peak Observatory, Sunspot, N. Mex.). Solar Phys.; 20: No. 2, 275-81(Nov 1971).

Horizontally averaged nonthermal velocities from Jensen and Orrall's (1963) observations of Doppler widths of weak rare-earth emission lines in the wings of H and K were determined. Combining these results with previous rare-earth line results, it was concluded that this velocity in the low chromosphere (300 to 600 km) is 2.0 ± 0.2 km/s, and changes little with height. (auth)

13032 COMPARISON OF THE INTENSITY VARIATIONS OF THE CN PHOTOSPHERIC AND K LINE CHROMOSPHERIC NETWORK WITH TIME. Liu, S. Y. (Univ. of Maryland, College Park); Sheeley, N. R. Jr. Solar Phys.; 20: No. 2, 282-5(Nov 1971).

As part of a program to study the behavior of various K-line spectral features both as a function of spatial position and time, time-lapse sequences of spectroheliograms were obtained simultaneously in the band head of CN at λ3883 and in the violet emission peak (K_{2v}) of Ca II λ3934. (W.D.M.)

13033 NATURE OF THE FINE STRUCTURE OF THE MIDDLE CHROMOSPHERE. Pikel'ner, S. B. (Astronomical Inst., Moscow). Solar Phys.; 20: No. 2, 286-94(Nov 1971).

Fine dark Hα filaments "fibrils" form at the limb, apparently in most of the middle chromosphere corresponding to an altitude between 1500 to 2000 km and 4000 km. The space in between filaments is corona and the transition layer. The "cool" gas in fibrils is protected by the magnetic field against the conductive flux out of the "hot" corona. Therefore the fibrils stretch up to 4000 km where their temperature is about 18,000 K and the density about 5×10^9 cm^{-3}. The gas in the fibrils is ionized by electronic collisions and by the external ultraviolet radiation. The second

level of the hydrogen atoms in fibrils is populated by recombinations, electronic collisions, and by Ly-α quanta. The calculated optical thickness of the fibrils in Hα is about 1, it explains the absorption features on the spectroheliograms. The gas pressure in fibrils is lower than the coronal pressure, and the pressure equilibrium is achieved by a magnetic field of about 1.5 to 2 G. In the active regions the photospheric fields are stronger, therefore the fibrils in active regions are wider and show more contrast. The emission of the fibrils at the limb is explained by the scattering of the solar radiation. The temperature in arches reaching as high as 5000 to 6000 km is stabilized near the top by the He II emission. Thus the middle chromosphere is essentially a collection of magnetic arches. (auth)

13034 OBSERVATION IN THE WING OF THE Hα LINE AND IDENTIFICATION OF THE SPICULAR STRUCTURE NEAR THE SOLAR LIMB. Koutchmy, S. (Institut d'Astrophysique, Paris); Macris, C. Solar Phys.; 20: No. 2, 295-7(Nov 1971).

The solar limb was studied using the 40 cm refractor of the Athens National Observatory which is equipped with a Lyot-type Halle Hα filter. The photographs were taken with a 0.5 Å passband; the resolution is excellent in the center of the Hα line as well as in the wings. The diameter of the solar disk on the original negatives is 155 mm (Alissandrakis and Macris, 1971). (W.D.M.)

13035 Hα FINE STRUCTURE AND THE CHROMOSPHERIC FIELD. Foukal, Peter (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 20: No. 2, 298-309(Nov 1971).

The physical characteristics of the Hα structures previously defined as fibrils and threads are studied. The interpretation of the fibrils as ends of flux tubes is useful in tracing the behavior of the transverse field component over the solar surface. The observed properties of fibrils and threads are consistent with the hypothesis that they are produced by a shock-wave mechanism similar to that advanced by Parker to explain spicules. It is suggested that the undisturbed magnetic field in the chromosphere of an active region is confined to a thin sheath, while the field of the quiet regions extends into the corona. (auth)

13036 NOTE ON CHROMOSPHERIC FINE STRUCTURE AT ACTIVE REGION POLARITY BOUNDARIES. Prata, Stephen W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 20: No. 2, 310-16(Nov 1971).

High-resolution Hα filtergrams from Big Bear Solar Observatory reveal that some filamentary features in active regions have fine structure and hence, magnetic field transverse to the gross structure and the zero longitudinal field line. These features are distinct from the usual active region filament, in which fine structure, magnetic field, and filament are all parallel to the zero longitudinal field line. The latter occur on boundaries between regions of weaker fields while the former occur at boundaries between regions of stronger field. (auth)

13037 OBSERVATIONS OF A PARTIAL SOLAR ECLIPSE AT 9 mm WAVELENGTH. Flett, A. M.; Foster, Patricia R.; Strachan, P.; Thornton, D. C. (Aberdeen Univ., Scotland). Solar Phys.; 20: No. 2, 317-21(Nov 1971).

Observations at 9-mm wavelength of the partial solar eclipse of February 25, 1971 were made to investigate possible limb brightening of the Sun. The results obtained show that less than 5% of the solar disc power can be contained in any such brightening. (auth)

13038 SIMPLE FORMULA FOR THE TOTAL DIELECTRONIC RECOMBINATION COEFFICIENT. Landini, M.; Monsignori Fossi, B. C. (Arcetri Observatory, Florence). Solar Phys.; 20: No. 2, 322-31(Nov 1971).

Two simple relationships for the total dielectronic recombination coefficient are developed. The first is for isoelectronic sequences of H, He, Ne, K–Ni and the second for Li–F, Na–Ar, and Cu–Kr. Comparison with the extended computations of Jordan and Elwert is made. (auth)

13039 ASYMMETRY OF SOLAR ACTIVITY IN THE YEARS 1959–1969. Waldmeier, M. (Swiss Federal Observatory, Zurich). Solar Phys.; 20: No. 2, 332-44(Nov 1971).

One of the most outstanding features of solar activity in the decade 1959–1969 was a very strong asymmetry on the two hemispheres. On the northern hemisphere spots, faculae, and prominences were more numerous and the white light corona was brighter than on the southern hemisphere. This happened as well in the main zone as in the polar zone. The green coronal line too was brighter on the northern hemisphere, but the intensity of the red line was asymmetric in the opposite sense. From this behavior it follows that over the more active hemisphere the corona is denser and hotter. Between density N_e and temperature T holds the relation: $N_e = 10^{-10}\ T^3$. The real asymmetry was strengthened by a phase difference of the two hemispheres. This phase shift is subject to a long period that contains 8 eleven-year cycles. The intensity of the individual cycles follows the same long period. With low maxima of solar activity the northern hemisphere precedes, with high maxima the southern hemisphere. (auth)

13040 FEATURE OF THE SECULARLY SMOOTHED MAXIMA OF SUNSPOT FREQUENCY. Henkel, R. (Univ., Frankfurt am Main). Solar Phys.; 20: No. 2, 345-7(Nov 1971).

If $W_M(N)$ denotes the maximum value of the yearly means of the relative sunspot numbers within one cycle, Bonov (1969) has shown that a relation exists between $W_M(2N+1)$ and $W_M(2N) + W_M(2N+2)$ which can be expressed by two formulas and that two formulas are valid for the relation between $W_M(2N)$ and $W_M(2N-1) + W_M(2N+1)$. This means that the series of even-numbered cycles as well as that of odd cycles must be subdivided into two parts with respect to these formulas. The distribution of either all even or odd cycles into two subdivisions, however, follows no obvious rule. As if one wants to use these formulas there is a certain arbitrariness in the choice of one of the two possible formulas. In order to overcome this difficulty the secularly smoothed $R^*_M(N)$ values were investigated instead of $W_M(2N)$ or $W_M(2N+1)$ respectively as it was carried out by Bonov. (W.D.M.)

13041 DYNAMICS OF A TOROIDAL MAGNETIC RING. Lilliequist, Carl G.; Altschuler, Martin D.; Nakagawa, Yoshinari (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 20: No. 2, 348-61(Nov 1971).

Solving the nonlinear partial differential equations of magnetohydrodynamics numerically, (1) the time development of a purely toroidal magnetic field (a magnetic ring) and (2) the interaction of a magnetic ring with a poloidal magnetic field were examined. Axisymmetry and incompressibility were assumed. Parameters were chosen to correspond to photospheric conditions. In case (1), the magnetic ring contracts to the axis and then splits in two with one ring traveling up along the axis and the other down. In case (2), a large toroidal velocity field is generated which has opposite direction of flow above and below the magnetic ring. The magnetic and flow patterns of case (2) may persist with little change for a relatively long time. It is conjectured that toroidal magnetic fields may be involved in the bright rings of sunspots or in the dynamics of spicules. (auth)

13042 SOLUTION OF THE TRANSFER EQUATION SYSTEM FOR A NONSCATTERING MEDIUM WITH A HOMOGENEOUS MAGNETIC FIELD. Katz, J. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Irkutsk, USSR). Solar Phys.; 20: No. 2, 362-4(Nov 1971).

The exact solution of the boundary problem for the system of three transfer equations with Unno's absorption matrix was obtained by Kjeldseth Moe (1968) who studied the formation of Fraunhofer lines in a magnetoactive atmosphere. Another method is described, which gives the exact solution of the boundary problem for a transfer equation system of any order with an arbitrary absorption matrix. (W.D.M.)

13043 MAGNETO-OPTICAL EFFECTS IN SUNSPOTS. Wittmann, A. (Univ., Goettingen, Ger.). Solar Phys.; 20: No. 2, 365-8(Nov 1971).

Magneto-optical effects on the circular polarization within the line Fe I λ 6302.5 were investigated. Quantitative results on the V-reversal near the line center are given for homogeneous magnetic fields. (auth)

13044 FURTHER STUDY OF H_2O LINES IN THE UMBRAL SPECTRUM IN THE REGION OF 0.93μ. Mallia, E. A.; Blackwell, D. E.; Petford, A. D. (Oxford Univ.). Solar Phys.; 20: No. 2, 369-71(Nov 1971).

The presence in the umbral spectrum of lines from the vibration–rotation bands of the H_2O molecule has been reported by several authors and the problems of identification discussed by them (Mallia and Blackwell, 1970; Mallia et al., 1970; Wöhl, 1969; Wöhl, 1971). These identifications have been based on spectra obtained in the visible region around λ 5880 and in the near infrared at λ 9280. However, the problem of allowing for the H_2O absorption lines in the spectrum of the Earth's atmosphere is a very difficult one. In these circumstances, and because more information about the H_2O spectrum is now available, a re-appraisal was made of the identification of H_2O lines in the umbral spectrum using a new spectrum in the region of λ 9280 obtained at the Gornergrat station. (W.D.M.)

13045 CORONAL MAGNETIC FIELD OF THE SUN ON JANUARY 7, 1969. Trotter, Dorothy E.; Newkirk, Gordon Jr. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 20: No. 2, 372-4(Nov 1971).

Recently Lantos-Jarry (1970) inferred the existence of a magnetic arch connecting an active region with a neighboring faculae region, which was the remnant of a previously active center. This inference was based upon the consistent displacement of Type I bursts and continuum noise storm observed at 169 MHz (a height of about 100,000 km) westward from the active center by approximately 10°. Attention is drawn to the fact that the calculated magnetic fields in the corona for this period confirm Lantos-Jarry's inference of magnetic arches connecting the two regions. (W.D.M.)

13046 HIGH DISPERSION SPECTROSCOPIC STUDY OF QUIESCENT PROMINENCES. Engvold, O. (Inst. for Theoretical Astrophysics, Oslo); Livingston, W. Solar Phys.; 20: No. 2, 375-88(Nov 1971).

The utility of very high-dispersion spectra (5 to 11 mm/Å) for the study of line profile and velocity structure in quiescent prominences is demonstrated by observations, taken with the spectrographic slit positioned normal to the limb in Hα λ 6563 Å, He D_3 λ 5876 Å, and Ca^+K λ 3933 Å. The emission profiles of both Hα and the K line often show a central reversal (absorption). Emission structures in the K-line can be complex with details as narrow as 0.04 Å. Frequently, this structure consists of two distinct components: a central, strong, rather narrow line, and an often displaced, weak feature of undefined profile appearing as "fuzz". It is suggested that this fuzz indicates an exchange of matter between the prominence and the corona. (auth)

13047 CORONAGRAPHIC OBSERVATIONS OF AN ENHANCED CORONAL REGION. I. FeXII AND NiXV EMISSION LINE DATA. Fisher, R.; Pope, T. (Univ. of Hawaii, Honolulu). Solar Phys.; 20: No. 2, 389-99(Nov 1971).

Nine coronal emission lines representing five stages of Fe ionization and one stage of Ni were observed in an enhanced coronal region. The data from these observations are presented along with a density model of the enhanced region obtained from the Fe XIII and Ni XV emission line ratios as a function of position angle. The electron densities obtained from Fe XIII lines range from $N_e = 10^8$ to 10^9 cm^{-3}, and are slightly lower for Ni XV line data. Estimates of the variation of temperature over the enhanced region are inferred from the observed line intensities. (auth)

13048 TIME BEHAVIOR OF TEMPERATURE AND EMISSION MEASURE IN X-RAY FLARES. Milkey, Robert W.; Blocker, Norman K.; Chambers, William H.; (and others) (Los Alamos Scientific Lab., N. Mex.). Solar Phys.; 20: No. 2, 400-12(Nov 1971).

X-ray observations from Vela-5 spacecraft of five flares occurring in November and December 1969 were reduced to temperatures and emission measures as a function of time. This reduction was done assuming a thermal spectrum including free–free and free–bound emission. A phenomenological model is proposed to explain the nature of the time behavior of the temperature and emission measure. (auth)

13049 ANISOTROPY OF SOLAR HARD X-RADIATION DURING FLARES. Elwert, Gerhard; Haug, Eberhard (Univ., Tuebingen, Ger.). Solar Phys.; 20: No. 2, 413-21(Nov 1971).

The angular distribution of solar-flare associated hard x rays ($\gtrsim$10 keV) was calculated on the assumption that they originate as bremsstrahlung emission of energetic electrons with a power law spectrum. For the cross section the relativistic Sauter formula was used. Supposing the electrons to move in a fixed direction, the x radiation is considerably anisotropic, especially at high photon energies. Taking into account a magnetic field, the anisotropy decreases with increasing pitch angles of the electrons. The anisotropic angular distribution of solar x radiation seems to be connected with the center-to-limb variation of hard x-ray bursts and with the correlation of shortwave fadeouts and geomagnetic crochets to Hα flares. (auth)

13050 DISCUSSION OF PAPER ON THE POLARIZATION AND ANISOTROPY OF SOLAR X-RADIATION DURING FLARES, BY G. ELWERT AND E. HAUG. Kahler, S. W.; Doschek, G. A.; Meekins, J. F.; Horan, D. M. (Naval Research Lab., Washington, D. C.). Solar Phys.; 20: No. 2, 422-7(Nov 1971).

A number of studies of the 1- to 10-Å emission during solar flares have been reported in the last several years. Results of data from proportional counters (Kahler et al., 1970; Culhane and Phillips, 1970), GM tubes (Drake, 1970), ion chambers (Horan, 1970), and crystal spectrometers (Meekins et al., 1970; Neupert, 1968) have generally been consistent with a thermal emission interpretation. The reported temperatures cover a range of $\approx 4 \times 10^6 < T \lesssim 40 \times 10^6$ K. In contrast to these results, Elwert and Haug (1970) interpreted proportional counter data from two solar x-ray flares as due to nonthermal bremsstrahlung. Several objections to their interpretation are discussed. A reply by Elwert and Haug is included. (W.D.M.)

13051 EXTREME-ULTRAVIOLET OBSERVATIONS OF A SURGE. Kirshner, Robert P. (Harvard Coll. Observatory, Cambridge, Mass); Noyes, Robert W. Solar Phys.; 20: No. 2, 428-37(Nov 1971).

A flare surge at the limb was observed in C III 977 Å by the Harvard OSO 6 spectroheliometer. The kinematic behavior of the surge is the same in C III and in Hα. The amount of C III emission is consistent with a model in which the C III ions occupy sheaths with thickness ~100 km surrounding the cooler Hα-emitting threads. The mass of the material containing C III ions is about 10^{-2} times that emitting Hα. (auth)

13052 MOVING TYPE IV RADIO BURST AND ITS RELATION TO THE CORONAL MAGNETIC FIELD. Dulk, George A. (Univ. of Colorado, Boulder); Altschuler, Martin D. Solar Phys.; 20: No. 2, 438-47(Nov 1971).

A moving Type-IV burst, observed with the Culgoora radioheliograph on April 29, 1970 moved out to about 3 $R_\odot$ and attained high circular polarization before fading. The appearance of the moving Type-IV source suggests an isolated, self-contained, synchrotron emitting plasmoid. Magnetic field maps of the corona derived from photospheric observations indicate that the plasmoid moved almost radially outward from the flare region along open field lines. To explain the observed source structure and high unipolar polarization, it is suggested that a ring of electric current was ejected from the low corona and guided by coronal magnetic field lines; the radio emission was synchrotron radiation generated by mildly relativistic electrons trapped in the poloidal magnetic field of the ring current. (auth)

13053 RELEASE OF ENERGETIC PARTICLES FROM THE SUN. Simnett, G. M. (Univ. of California, Riverside). Solar Phys.; 20: No. 2, 448-61(Nov 1971).

A model is developed to account for the release of solar cosmic rays from the Sun. The solar atmosphere out to 3 to 5 solar radii above the photosphere is permeated with magnetic field lines which trap low-rigidity ($\lesssim$50 MV) flare particles. Plasma heated by the flare process disturbs the trapping field, and not until the disturbance reaches 3 to 5 solar radii can the low-rigidity flare particles have access to interplanetary space. If the plasma is not heated sufficiently to overcome the coronal field, flare particles are trapped, efficiently. Subsequent leakage of these particles into interplanetary space forms corotating streams. Reference is made to satellite observations of solar electromagnetic radiation and charged particles. (auth)

13054 CORRELATION OF SOLAR-WIND VELOCITY WITH λ5303 CORONAL INTENSITY. Pathak, P. N. (Physical Research Lab., Ahmedabad, India). Solar Phys.; 20: No. 2, 462-73(Nov 1971).

Using solar-wind velocity data obtained by Mariner-2 and IMP-1 spacecrafts, an attempt was made to study its correlation with λ 5303 coronal intensity. It is shown that the long-lasting regions of enhanced λ 5303 intensity in the solar corona are well correlated with recurrent streams of solar wind having high velocity. The time lag between the central meridian passage (CMP) of the coronal features and the detection of the solar-wind streams at the spacecraft was found to be smaller than that implied by a radial solar wind. Significant positive correlations for Mariner-2 data were obtained for coronal intensity at heliolatitudes 5° S to 10° N with a time lag of +2 days while for IMP-1 data, high positive correlations were obtained for the southern heliolatitudes (10 to 25° S) without any time lag. It should be noted that the average heliographic latitudes for Mariner-2 and IMP-1 were ~4° N and ~4° S respectively during the periods covered by the present analysis. The implications of the results are discussed. (auth)

13055 SEARCH FOR SOLAR NEUTRONS NEAR SOLAR MAXIMUM. II. Cortellessa, Paolo; Di Benedetto, Paolo, Paizis, Constantinos (Univ., Milan. CNR, Milan). Solar Phys.; 20: No. 2, 474-90(Nov 1971).

A plastic scintillator counter with anticoincidence screen has flown in four balloon flights at a floating altitude variable between 4 and 5 mb, during night to day, daytime, and nighttime flights. The analysis and comparison of the daytime and nighttime parts of the flights have given for the continuous emission flux an upper limit of 5.5×10^{-3} n/cm^2 s over the energy range from 10 to 200 MeV. This upper limit is converted into upper limit differential

solar neutron spectrum to be compared with the results obtained from other experiments. An irregular excess in counting rate observed in one of the flights, resulting in a day–night difference, is discussed. The problems encountered in the operation of this type of detector at a high level of sensitivity are also discussed. (auth)

13056 OBSERVATIONS OF THE VARIATION OF TEMPERATURE WITH LATITUDE IN THE UPPER SOLAR PHOTOSPHERE. Altrock, Richard C.; Canfield, Richard C. (Sacramento Peak Observatory, Calif.). Astrophys. J.; 171: No. 2, L71-4(15 Jan 1972).

Photoelectric meridional and equatorial limb-darkening scans were made during the period 15–22 June 1971, using a spectral region of 30 mÅ width centered 0.77 Å to the red of Ca II K_3. The radiation observed originates at $\tau_{5000} \simeq 10^{-3}$. At the time of the observations the temperature relative to the equatorial temperature was enhanced by 8°K ± 2.5°K at active-region latitudes and 5°K ± 2°K at latitude 50°N. (auth)

13057 BROADENING OF THE SOLAR SODIUM D-LINES BY ATOMIC HYDROGEN. McNamara, L. F. (Commonwealth Centre, Sydney). Proc. Astron. Soc. Aust.; 2: No. 1, 40-1 (Jul 1971).

Molecular energies for the system Na–H were calculated by the valence configuration–interaction method and are illustrated. The variation with temperature of the calculated (half) half width (per neutral H atom) of the D2 line is also shown. (Australia)

13058 INFINITE FINE STRUCTURE COUPLING IN RADIATIVE TRANSFER PROBLEMS. McNamara, L. F. (Commonwealth Centre, Sydney). Proc. Astron. Soc. Aust.; 2: No. 1, 41-2(Jul 1971).

Multilevel atom transfer problems are treated by consideration of the limit as an infinite fine structure collision rate and a modified form of the line source function equation is derived. Functions for a 3-level atom in a uniform atmosphere are depicted. (Australia)

13059 FAST METHOD FOR THE DETERMINATION OF EMERGENT INTENSITIES IN RADIATIVE TRANSFER THEORY. Cannon, C. J. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 2: No. 1, 42-3(Jul 1971).

A new method is presented for evaluating the emergent intensity, once the so-called source function is known. The method is fast and very easy to program. (W.D.M.)

13060 EVOLUTION OF A JET-LIKE STRUCTURE IN THE LATE PHASE OF A COMPLEX SOLAR OUTBURST. Riddle, A. C.; Sheridan, K. V. (CSIRO, Sydney). Proc. Astron. Soc. Aust.; 2: No. 1, 62-5(Jul 1971).

A new feature in the form of a jet formed by close juxtaposition of a number of highly polarized, separately resolved 80-MHz sources was observed as the late phase of a very complex outburst on January 25, 1971. A source model is presented that can explain the observed source properties. The early phase, also complex and involving numerous moving sources, is described. (auth) (Australia)

13061 ASYMPTOTIC METHODS IN THE THEORY OF NONLINEAR CONVECTION. van der Borght, R. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust.; 2: No. 1, 45-6(Jul 1971).

Comparison is made between results obtained by numerical integration and by the asymptotic theory. (Australia)

13062 IMPROVED VITENSE MODEL OF THE SOLAR CONVECTION ZONE. van der Borght, R. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust.; 2: No. 1, 46-7(Jul 1971).

A comparison is made between the Böhm–Vitense and Unno theories. Two methods for obtaining first-order solutions to the Unno equations are suggested. (Australia)

13063 NONLINEAR CONVECTION WITH VARIABLE VISCOSITY AND THERMAL CONDUCTIVITY. van der Borght, R.; Waters, B. E. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust.; 2: No. 1, 47-8(Jul 1971).

Investigations of the temperature distribution in the solar convective layer are made. Conductivity and viscosity are not considered constant. (Australia)

13064 DEPTH DEPENDENCE ON THE VARIOUS SCALE LENGTHS IN A QUASI-VITENSE MODEL OF THE SOLAR CONVECTION ZONE. Waters, B. E. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust.; 2: No. 1, 48-50(Jul 1971).

The lengths l_1, l_2, l_3, and l_4 assumed proportional to scale height from Böhm–Vitense theory are expressed as expansions of functions f_ω, f_Θ, f_t, and f_r. (Australia)

13065 DEPTH DEPENDENCE OF PHYSICAL PARAMETERS ASSOCIATED WITH CONVECTION IN THE SOLAR ATMOSPHERE. Waters, B. E. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust.; 2: No. 1, 50-1(Jul 1971).

Scale height, volume expansion coefficient, eddy viscosity, thermal conductivity, effective Rayleigh number, effective Prandtl number, specific heat at constant volume, and average vertical velocity are plotted against depth for the first 300 km of the convection zone. (Australia)

13066 NONLINEAR CONVECTION WITH FREE BOUNDARIES AT HIGH RAYLEIGH NUMBER. Murphy, J. O. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust.; 2: No. 1, 51-2(Jul 1971).

Temperature fluctuations for Rayleigh number $R = 10^7$ are obtained for wave number = 0.0033π, 0.6000π, and 17.7181π. (Australia)

13067 NONLINEAR CONVECTION WITH HEXAGONAL PLANFORM. Murphy, J. O. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust.; 2: No. 1, 53-4(Jul 1971).

Temperature fluctuations for hexagonal planform where Rayleigh number $R = 10^5$ are obtained for wave numbers = 0.500π, 3.000π, and 5.000π, where the Prandtl number is 0.10. (Australia)

13068 HYDROMAGNETIC STRUCTURE AT THE BOUNDARY OF A SUPERGRANULE. Ribes, E.; Unno, W. (CSIRO, Sydney). Proc. Astron. Soc. Aust.; 2: No. 1, 54-5(Jul 1971).

The development of the magnetic configuration driven by a supergranular convection overshooting into the photosphere is considered, together with the question of whether the concentration of magnetic field, the downward motion, and the temperature excess observed at the boundaries of supergranules can be interpreted consistently in terms of a steady flow along the magnetic lines of force. (Australia)

13069 POSSIBLE CAUSES OF LINE SPLITTING IN DRIFT PAIR SOLAR BURSTS. Melrose, D. B.; Sy, W. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust.; 2: No. 1, 56-7(Jul 1971).

Possible causes of line splitting in emission near the local plasma frequency are considered in connection with drift pair solar radio bursts. The basic model envisaged for the bursts involves a bunch of electrons streaming through the solar corona at several times the thermal velocity of electrons. The emission process assumed is the transformation of coherently generated electron plasma waves (l-waves) into electromagnetic waves (t-waves) with little change in frequency. (Australia)

13070 CORONAL DISTURBANCE OBSERVED SIMULTANEOUSLY WITH A WHITE-LIGHT CORONAMETER AND THE 80-MHz CULGOORA RADIOHELIOGRAPH. Hansen, R. T. (High Altitude Observatory, Mauna Loa, Hawaii); Garcia, C. J.; Grognard, R. J.-M.; Sheridan, K. V. Proc. Astron. Soc. Aust.; 2: No. 1, 57-60(Jul 1971).

Observations on August 11 and 12, 1970 at Mauna Loa (Hawaii) of the white-light corona revealed a rare solar event in the form of a short-lived coronal brightening off the eastern limb of the Sun. The intensity of this region, as measured at a distance $\rho = 1.5$ (where $\rho = R/R_\odot$), more than doubled over a period of five hours and then fell very abruptly (~10 min) to below its initial brightness. A complex radio event in the same region was observed simultaneously with the 80-MHz radioheliograph at Culgoora (Australia). Associations between the optical and radio events are described and the physical implications briefly discussed. (auth) (Australia)

13071 MULTIPLE MAGNETIC-LOOP STRUCTURE OF A TYPE IV SOLAR RADIO OUTBURST. Stewart, R. T.; Sheridan, K. V. (CSIRO, Sydney). Proc. Astron. Soc. Aust.; 2: No. 1, 60-2(Jul 1971).

80-MHz heliograph observations of the multiple source structure and polarization of a Type IV solar radio outburst on November 16, 1970 are discussed. At times during the event, six sources were present. Three of these were highly circularly polarized in a L.H. sense and two in a R.H. sense. The sixth source was extended and had oppositely polarized edges. From the source behaviour it was concluded that the radio emission came from two expanding and one stationary magnetic arches. (auth) (Australia)

13072 TOTAL FLUX AND POLARIZATION MEASUREMENTS OF S COMPONENT OF THE SUN AT MM WAVELENGTHS. Feix, G. (Ruhr- Univ., Bochum, Ger.). Astron. Astrophys.; 16: No. 2, 268-71(Jan 1971).

Observations at 81 and 250 GHz of the slowly varying component were performed. The measurements were made using a 36-foot antenna. The polarization degree at 81 GHz as measured by a

pencil beam of 1.2' was ≤ ±0.8%, while at 36 GHz the average value of ±2% was accepted from previous observations. The optical depths of the radio source at mm wavelengths are given by evaluating the QL propagation of mm waves on the assumption of the magnetoionic theory. (auth)

13073 PHOTOMETRY OF A SUNSPOT AT $\lambda = 3.75\mu$. Coupiac, P.; Koutchmy, S. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 16: No. 2, 272-5(Jan 1972). (In French)

A sunspot with an umbra of 16'' was observed in the 11145 MacMath plage during Feb. 1971. The coelostat of the Pic-du-Midi observatory with an aperture of 50 cm was used in the infrared range. Good photometric scans were obtained by spatial cancellation techniques using a modulation frequency of 330 Hz and amplitudes <4'' with a 0.34 μ band pass filter and InSb detector at a wavelength of 3.75 μ; the spatial derivates of the photometric sunspot profiles were calibrated by scanning the extreme limb profile. This technique offers the advantage of permitting a very effective filtering of low-frequency noise of atmospheric origin. In this range a 0.60 ± 0.03 (uncorrected for the seeing) umbra photosphere contrast was obtained, this giving an umbral temperature of 4200 ± 120°K. This value is in agreement with the computed predictions of the recent models of the Henoux (1969) and of Stellmacher and Wiehr (1970). Bode (1965) diagrams were used to deduce τ (5000). (auth)

13074 PERTURBATION ANALYSIS OF RADIATIVE–CONDUCTIVE COUPLING. Cess, R. D. (State Univ. of New York, Stony Brook). Astron. Astrophys.; 16: No. 2, 327-8 (Jan 1972).

It is illustrated that the recent analyses of Frisch (1970, 1971), concerning radiative–conductive coupling in the solar chromosphere, may be interpreted within the framework of a singular perturbation. (auth)

13075 THEORY OF THE SOLAR 22-YEAR CYCLE. Piddington, J. H. (CSIRO, Sydney). Proc. Astron. Soc. Aust.; 2: No. 1, 7-10(Jul 1971).

It is shown that the cyclonic reversal mechanism (and hence the dynamo theory) is not applicable to the solar cycle from the fact that $[(\partial/\partial t) - \eta\nabla^2]A_\phi = \Gamma(r,t)B_\phi$ is invalid because the observed fields obey Hale's laws and show a high degree of regularity of group spot formation rather than randomization. A deeply penetrating magnetic field is proposed in place of the shallow poloidal field of the dynamo theory and a theory of the solar cycle is introduced based on this general field. (Australia)

13076 TRANSFER CHARACTERISTICS OF SOLAR RADIATION IN A SCATTERING CORONA. Caroubalos, C.; Aubier, M.; Leblanc, Y.; Steinberg, J. L. (Meudon Observatory, France). Astron. Astrophys.; 16: No. 3, 374-8(Feb 1972).

Using a spherically symmetric coronal model including inhomogeneities and a Monte Carlo method, it is shown that: (1) the "cut-off" introduced in the spectrum of a white point source by propagation conditions occurs at the plasma frequency f_p at the source level independently of the direction θ of observation; (2) the shape of the received spectrum is strongly θ-dependent; (3) the polar diagram of the emerging radiation, whatever the primary emission pattern is, tends towards a limit diagram when the frequency of emission f tends to f_p; this limiting pattern is set by scattering; (4) the two effects, focusing and scattering, are in competition; at high frequencies, focusing is predominant if the primary pattern of the source is broad, whereas with a strongly directive primary pattern, scattering produces a broader one at emergence at all frequencies; (5) the rate of decay of the coronal transient response, due to multipath propagation, increases rapidly when $f \to f_p$; but it only takes a value $\tau \approx 0.6$ s comparable to the time scale of observed meter-wave events if the primary diagram is broad; and (6) the excess group delay is always smaller than computed without inhomogeneities. (auth)

13077 ABUNDANCES IN THE SOLAR CORONA. de Boer, K. S.; Olthof, H.; Pottasch, S. R. (Univ., Groningen, Netherlands). Astron. Astrophys.; 16: No. 3, 417-30(Feb 1972).

By using coronal measurements of the May 30, 1965 eclipse and improved atomic parameters, the coronal abundances are discussed. Two new line identifications are suggested, and several existing suggestions for possible identifications are discussed on the basis of predicted intensities and abundances. Finally, an extensive list is given of lines that are possibly observable, together with predicted intensity and equivalent width. (auth)

13078 GAMMA RAY AND NEUTRON EMISSION FROM THE SUN. Chupp, E. L. (Univ. of New Hampshire, Durham). Space Sci. Rev.; 12: No. 4, 486-525(Nov 1971).

Evidence for acceleration of charged particles in the solar atmosphere is reviewed with specific reference to production of gamma rays and neutrons at the Sun. Fluxes of these components at the Earth, based on theoretical assumptions are also reviewed and estimates and conditions for obtaining observable fluxes from Syrovatskii's dynamic dissipation model are considered. Knowledge about the Sun, to be derived from such observations, is discussed. Finally, a brief review of the present status of experimental observations and suggestions for new experimental approaches are given. 102 references. (auth)

13079 CORRELATION OF INTERPLANETARY-SPACE B_z FIELD FLUCTUATIONS AND TRAPPED-PARTICLE REDISTRIBUTION. Parks, George K. (Univ. of Washington, Seattle); Pellat, Rene. J. Geophys. Res.; 77: No. 1, 266-9(1 Jan 1972).

The ATS-1 geostationary satellite was used on Aug. 26–29, 1967 to observe fluctuations of the ecliptic polar component of the interplanetary magnetic field covering local times between noon and midnight. Trapped ATS-1 electron fluxes in this local-time sector are minimally affected by substorm activities. Observations of correlated interplanetary magnetic-field and trapped-particle fluctuations were made. Properties of the magnetospheric electric field are deduced from observations of the particle-redistribution effects. The interplanetary fluctuations possibly represent a strong driving source for particle diffusion. It is demonstrated that the interplanetary fluctuations directly affect the magnetospheric particle distribution that are a frequent occurrence in the interplanetary medium, especially if the solar wind is disturbed. (J.C.W.)

Galaxies

13080 MEAN AND THE MEAN SQUARED ELECTRON DENSITY IN INTERSTELLAR SPACE. Walmsley, Malcolm (Max-Planck-Institut fuer Radioastronomie, Bonn); Grewing, Michael. Astrophys. Lett.; 9: No. 4, 185-8(Nov-Dec 1971).

It is suggested that the late-O and early-B-type stars situated in low-density regions could account for much of the current observational data relating to the ionization in the interstellar medium. The recently observed recombination line radiation, however, requires a separate explanation. (auth)

13081 NEW THEORY FOR GIANT LOOPS. Brandt, J. C.; Maran, S. P. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London); 235: No. 5332, 38-9(7 Jan 1972).

The four very large shell-shaped features (galactic spurs) that have been observed from radio emission surveys of the Galaxy are discussed. These are polarized nonthermal radio sources that appear to be associated with faint optical emission nebulae. It is thought that these objects represent a different phenomenon from that typified by the much smaller Cygnus loop to which they are frequently compared. Interpretations of these loops are that they are very large and old supernova remnants, or are caused by synchrotron emission from cosmic-ray electrons moving through the galactic magnetic field in the vicinity of the Sun. These interpretations are examined. It is suggested that the giant loops represent a very old class of nebulae, induced by supernova radiation as opposed to supernova ejecta. This model provides a qualitative explanation for the spectral and polarization properties of the radio emission, and it is considered that the radiative output of the supernova process should be regarded as a possible energy source for both the giant loops and the large-scale ordering of the interstellar magnetic field that they represent. (UK)

13082 SPECTRA OF RADIO GALAXIES BETWEEN 10 AND 10,000 MHz. Stull, M. A. (Univ. of Michigan, Ann Arbor). Astron. J.; 76: No. 10, 970-9(Dec 1971).

Measurements were made of the 8000-MHz flux densities of 60 Parkes Catalogue radio galaxies with the University of Michigan 85-ft radio telescope. The radio spectra of these galaxies were formed by combining the 8000-MHz data with as many flux-density measurements at frequencies between 10 and 10,000 MHz as could be found for them in the literature. The principal conclusions concerning the spectra of the galaxies may be summarized as follows: (i) when spectra of radio galaxies are extended to 8,000 or 10,000 MHz, the proportion of curved spectra that belongs to class C^+ increases over that found in surveys at lower frequencies; (ii) spectral curvature is more readily detected when one has a large number of flux-density measurements over a wide range of frequencies; (iii) complex spectral curvature is rare; the spectra of all the galaxies can be represented by simple first- and second-order curves; and (iv) the correlation between spectral index and luminosity reported by Kellermann, Pauliny-Toth, and Williams (1969) is also found at 250 MHz, but not at 8000 MHz. (auth)

13083 DISTRIBUTION OF GALAXIES IN THE URSA MAJOR II CLUSTER. Bahcall, Neta A. (California Inst. of Tech., Pasadena. Tel-Aviv Univ., Israel). Astron. J.; 76: No. 10, 995-9 (Dec 1971).

Galaxy counts for the region of the Ursa Major II cluster of galaxies (Z = 0.134) are presented and the static properties of the cluster are derived. The cluster center is located by the symmetry of the galaxy distribution around a high-density point. The projected spatial density of galaxies is derived from circular ring counts and is converted to a spatial density. The density functions are similar to the density functions of previously studied, smaller-redshift clusters. There is a secondary maximum in the density distribution at a distance of about 1.2 Mpc from the center which may be physically significant. It is found that the Ursa Major II cluster has a diameter of about 52 min of arc and contains approximately 140 members to a photo-red magnitude of about 18m. (auth)

13084 UNITARY CLASSIFICATION FOR N GALAXIES. Morgan, W. W. (Univ. of Chicago). Astron. J.; 76: No. 10, 1000-2 (Dec 1971).

A general N-type classification for galaxies having unstable nuclei is described; it derives out of morphologies by Oznernoi, and by the writer. The N characteristic is represented by three subgroups (N+, N, N−), which are situated between the normal spirals on one side, and the QSS on the other. This arrangement formalizes the conclusions of a number of investigators. The classification is applied to a group of direct photographs of Zwicky compact objects obtained by Sargent with the 200-inch Hale reflector. (auth)

13085 UBV PHOTOMETRY IN THE NUCLEAR BULGE OF THE GALAXY. van den Bergh, Sidney (Univ. of Toronto, Ont.). Astron. J.; 76: No. 10, 1082-98(Dec 1971).

New photoelectric and photographic photometry to $V \simeq 17.7$, $B \simeq 19.0$, and $U \simeq 18.3$ in Baade's low-absorption window that is centered on NGC 6522 is presented. The following results were obtained: (i) Most of the red giants in the nuclear bulge of the Galaxy lie in a region of the color−magnitude diagram that is located between the red-giant branches of the metal-poor globular cluster M3 and the old metal-rich open cluster NGC 188. (ii) The lower (metal-rich) part of this region is more strongly populated than is the upper (metal-poor) part. (iii) Observations of "star-free" sky patches show that the integrated colors of the subgiants and main-sequence stars in the nuclear bulge resemble those of a metal-rich stellar population. (iv) The reddening in the direction of NGC 6522 is found to be $E_{B-V} = 0.45 \pm 0.03$ m.e. Assuming that $R = A_V/E_{B-V} = 3.3 \pm 0.6$ and that $\langle M_V \rangle_{RR} = +0.5 \pm 0.3$ then yields a distance modulus $(m - M)_0 = 14.87 \pm 0.46$ for the nuclear bulge. The corresponding distance to the galactic center is 9.4 (+2.2, −1.8) kpc. (auth)

13086 PECULIAR EXTRAGALACTIC SYSTEM NGC 6438. Burbridge, Margaret E.; Burbidge, G. R. (Univ. of California, San Diego). Astrophys. J.; 171: No. 2, 253-5(15 Jan 1972).

The peculiar interacting system NGC 6438 was investigated at the Cerro Tololo Inter-American Observatory. It is shown that the irregular component and the S0 component have about the same redshift velocity of +2400 km s^{-1}, so that the large velocity differences originally reported by Sersic are not confirmed. (auth)

13087 RELATIVE LINE STRENGTHS OF INTENSE EXTREME-ULTRAVIOLET LINES OF Na I AND THEIR IMPORTANCE IN ESTIMATING INTERSTELLAR ABUNDANCES. Mansfield, M. W. D.; Connerade, J. P. (European Space Research Inst., Rome). Astrophys. J.; 171: No. 2, 391-2(15 Jan 1972).

Measurements of the relative line intensities of the stronger Na I $2p^6\ 3s\ {}^2S_{\frac{1}{2}} - 2p^5\ 3s\ nl$ transitions are reported. The importance of these lines in the estimation of interstellar abundances is noted, and it is suggested that a detailed calculation of the cross sections of the $2p^6\ 3s\ {}^2S_{\frac{1}{2}} - 2p^5\ 3s^2\ {}^2P$ transitions coupled with the data presented could lead to a better approximation to the Na I photon absorption cross section in the extreme ultraviolet. (auth)

13088 STELLAR CONTENT OF THE NUCLEI OF NEARBY GALAXIES. II. A NOTE ON NGC 4594. Spinrad, Hyron (Univ. of California, Berkeley); Taylor, Benjamin J. Astrophys. J.; 171: No. 2, 397-401(15 Jan 1972).

Scans of the nuclear regions of the giant Sa galaxy NGC 4594 were obtained on the Spinrad−Taylor photometric system. A synthesis of the galaxy spectrum in terms of stellar constituents yielded a population model similar to, but containing somewhat redder stars than, the nuclei of M31 and M81. (auth)

13089 SCANNER ABUNDANCE STUDIES. V. GLOBULAR CLUSTERS IN M31. Spinrad, Hyron; Schweizer, Francois (Univ. of California, Berkeley). Astrophys. J.; 171: No. 2, 403-10(15 Jan 1972).

Photoelectric observations of eight luminous globular clusters in M31 confirm and extend van den Bergh's conclusions about the wide range of metallic-line strength in their integrated spectra. Spectra synthesized from several crude models of the clusters' stellar content were compared to the observed scanner spectra; from the best-fitting model it appears very likely that the M31 globular clusters with the strongest lines, H87, B282, and MII, are super-metal-rich. The presence of hot stars is required to explain their strong ultraviolet and blue continua. In galactic globular clusters, hot stars belong to well-populated, blue horizontal branches in metal-poor systems. The strong-line M31 globular clusters have no apparent galactic counterparts in this respect. (auth)

13090 INTERSTELLAR CALCIUM FEATURE IN THE REGION OF ETA CARINAE. Walborn, Nolan R. (Univ. of Toronto). Publ. Astron. Soc. Pac.; 83: No. 496, 811-12(Dec 1971).

The stars in the immediate vicinity of η Carinae show considerably stronger interstellar calcium lines than the surrounding stars on all sides. There is some evidence that the enhanced interstellar absorption is due to material associated with the stars and further observations would be of interest. (auth)

13091 NEBULOUS OBJECTS NEAR MAFFEI 1. van den Bergh, Sidney (Univ. of Toronto). Publ. Astron. Soc. Pac.; 83: No. 496, 822-3(Dec 1971).

Three nebulous objects have been found within 350″ of the center of Maffei 1. The discovery of a prominent dust lane in Maffei 1 by Ford and Jenner is confirmed. (auth)

13092 FURTHER EVIDENCE OF EXPLOSIVE EVENTS IN THE GALACTIC NUCLEUS. Sanders, R. H. (Columbia Univ., N. Y.); Wrixon, G. T.; Penzias, A. A. Astron. Astrophys.; 16: No. 2, 322-6(Jan 1972).

A survey of high-velocity hydrogen was carried out in a region near the galactic center ($358° < l^{II} < 12°$; $-12° < b^{II} < 0°$) using the 20-ft horn reflector at Crawford Hill. The purpose of this survey was to observe high-velocity hydrogen possibly associated with the galactic center and to map the extent of this hydrogen. The observations were of low resolution (~2°), but high sensitivity, with a minimum detectable brightness temperature of 0.06°K. Negative-velocity hydrogen in the range -340 km/s $< V < -40$ km/s was looked for primarily, and a large feature was observed south of the plane which has been seen by previous investigators such as van der Kruit (1970). It is suggested that this feature might be a ring of gas 2.4 kpc from the center with an expansion velocity of 128 km/s and a rotational velocity of 151 km/s. A high-velocity feature (i.e., −172 km/s) was also observed near the center that might be associated with continual high-angle expulsion of mass from the nucleus. It is concluded that these observations are consistent with a picture of recurring explosive events in the galactic nucleus, as well as a more continual form of mass expulsion. (auth)

13093 MASS–LUMINOSITY RATIO OF SPIRAL GALAXIES. Lewis, B. M. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). Astron. Astrophys.; 16: No. 2, 165-71(Jan 1972).

The rise in the mass−luminosity ratio in the outer parts of spiral galaxies can be explained if most of the mass is in the form of neutral hydrogen, with a temperature of 1 to 10°K. A model of NGC 300 with 87% of the mass in the form of a disk of cold gas is shown to provide an adequate explanation of the 21-cm observations. (auth)

13094 BLUE FILAMENT IN THE SOUTHERN MILKY WAY. Schlosser, W. (Ruhr Univ., Bochum, Ger.). Astron. Astrophys.; 16: No. 3, 486-8(Feb 1972). (In German).

One of the most striking features on wide-angle photographs of the southern Milky Way in the ultraviolet (3200 to 3800 Å) is a thin filament, which stretches from about $l = 325$ to 345°. This filament is the axis of symmetry for all open clusters in that region of galactic longitude with respect to distribution and distance. Thus, evidence is accumulating that this filament displays the optically most active part of the spiral arm. The distance of the structure as inferred from the clusters is 1600 pc, the half width of its central core according to surface photometry about 15 pc. (auth)

13095 CRITICAL DISCUSSION OF HEILES' CLOUDLETS. Rots, Arnold H.; Schwarz, Ulrich J.; van Woerden, Hugo (Sterrenkundig Laboratorium Kapteyn, Groningen, Netherlands). Astron. Astrophys.; 16: No. 3, 344-7(Feb 1972).

Heiles' procedures for defining cloudlets and determining their properties are criticized. His distribution functions of cloudlet properties must be distorted by instrumental resolution and ob-

servational selection. His list of cloudlets must contain objects of quite different nature: small, isolated clouds; condensations inside larger clouds; and irregularities in the geometry, density, and/or velocity distribution of larger structures. These conclusions strongly affect the size and mass spectra of interstellar clouds. (auth)

13096 TIME-DEPENDENT RADIATIVE TRANSFER. DAMPING OF A TEMPERATURE FLUCTUATION. II. THE TWO-LEVEL ATOM CASE. APPLICATIONS TO THE INTERSTELLAR MEDIUM. Le Guet, F. (Observatoire, Nice). Astron. Astrophys.; 16: No. 3, 356-60(Feb 1972).

Radiative damping of harmonic temperature fluctuations was studied by means of monochromatic radiation in an infinite homogeneous gas in LTE. If the gas is optically thick in the line, the relaxation time t_R is of a diffusive type: $t_R \propto \tau^2 \times t_d$. The mean time t_d between two consecutive scatterings of the photons is the sum of (i) the mean time of flight and (ii) the mean time of "capture" of the photons. In order to find out the time of capture, the transfer equation and the equations of statistical equilibrium are solved simultaneously. Preliminary results show that in interstellar clouds the time of capture can be much longer than the time of flight. (auth)

13097 DETECTABILITY OF IONIZED NEON AT THE GALACTIC CENTER. Kaufman, M. (State Univ. of New York, Stony Brook). Astron. Astrophys.; 16: No. 3, 361-8(Feb 1972).

Infrared measurements of the galactic nucleus by Low et al. (1969) are interpreted in terms of a [Ne II] emission line at 12.8 μ superimposed on a continuum. If neon is responsible for the total apparent excess flux at 13 ± 0.5 μ, then lunar-occultation and radio recombination-line data for Sgr A seem to indicate either (1) that the neon abundance in the galactic nucleus is at least 3 to 5 times the standard value for the Galaxy, or (2) that nonthermal processes are important. With this model for the galactic nucleus, the [Ne II] 12.8-μ line should be the strongest emission line in the 1- to 25-μ region of the spectrum. With allowance for the absorption of resonantly trapped 1.08-μ photons by dust particles mixed with the ionized gas, the postulated [Ne II] emission models can be made consistent with the upper limit obtained by Spinrad et al. (1971) for the equivalent width of He I λ1.08 μ. (auth)

13098 CHEMICAL CONSTITUENTS OF INTERSTELLAR CLOUDS. Buhl, D. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London); 234: No. 5328, 332-4(10 Dec 1971).

A review is given of present knowledge of the chemistry of interstellar clouds, together with an indication as to where the most promising future developments appear likely to occur. A short account of early discoveries is followed by a discussion on the detection of formaldehyde and on the presence of OH radicals and CO, including their isotopic varieties. The position with regard to larger molecules is considered, together with possible connections between interstellar molecular clouds and the origin of life. (UK)

13099 REDSHIFTS OF GALAXIES. Jaakkola, T. (Univ. of Helsinki). Nature (London); 234: No. 5331, 534-5(31 Dec 1971).

Redshifts of galaxies in clusters, groups, and pairs with respect to type, magnitude, diameters, colors, and inclinations were studied, and systematic differences between the redshifts of different types of galaxies were found. The total number of galaxies studied, with known redshifts and types, was 550. An analysis was made to test the assumption of a systematic redshift effect depending on the magnitude of the galaxy, according to which fainter galaxies have larger redshifts, and it is stated that the problem appears to be more complicated than had been supposed. Some of these difficulties are discussed. (UK)

Cosmology

Refer also to abstracts 13470, 13813, 13817, and 13818.

13100 METAGALACTIC GAMMA RAYS FROM RELATIVISTIC ELECTRON BREMSSTRAHLUNG INTERACTIONS. Stecker, F. W.; Morgan, D. L. Jr. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 171: No. 2, 201-7(15 Jan 1972).

Gamma-ray spectra calculated for relativistic-electron bremsstrahlung interactions at cosmological distances under the assumption of a single power-law source spectrum for the electrons are presented. It is concluded that such spectra cannot match the form of the observed cosmic γ-ray spectrum above 1 MeV, as has previously been suggested. (auth)

13101 UNLIKELINESS THAT MOLECULAR HYDROGEN STABILIZES CLUSTERS OF GALAXIES OR CLOSES THE UNIVERSE. Noonan, Thomas W. (Brockport State Coll., N. Y.). Astrophys. J.; 171: No. 2, 209-11(15 Jan 1972).

Photodissociation by ultraviolet radiation prevents the existence of intergalactic molecular hydrogen in sufficient amounts either to stabilize clusters of galaxies or to close the Universe. Molecular hydrogen in the coronas of elliptical galaxies is also excluded. (auth)

13102 POLYTROPIC AND ISOTHERMAL PLANE-SYMMETRIC CONFIGURATIONS. Harrison, E. R.; Lake, R. G. (Univ. of Massachusetts, Amherst). Astrophys. J.; 171: No. 2, 323-30(15 Jan 1972).

In rotating disk systems (e.g., spiral and S0 galaxies, the Saturn ring system, and Laplacian-disk cosmogonies) matter tends to be distributed in a plane-symmetric fashion about an equatorial plane. Such systems are idealized and it is assumed that density and pressure in the equilibrium state depend locally only on the perpendicular distance to the equatorial plane. It is shown that the hydrostatic equation, with the aid of the mass equation, can be integrated directly to give a pressure–mass relation. It is assumed that density and pressure are related by a polytropic equation of state: $p = K\rho^{1+1/n}$ and the solution for all plane-symmetric polytropes of $-1 < n \leq \infty$ are derived in closed form. Physical characteristics and also the solutions of the one-dimension Lane–Emden equation are discussed. (auth)

13103 SOME IMPLICATIONS OF A NEW VALUE FOR THE PRIMORDIAL SOLAR DEUTERIUM–HYDROGEN RATIO. Black, D. C. (Ames Research Center, Moffett Field, Calif.). Nature (London) Phys. Sci.; 234: No. 51, 148-9(20 Dec 1971).

The relative abundance of H and D at the time of formation of the solar system has usually been assumed to be $D/H = 1.5 \times 10^{-4}$, from measurements on carbonaceous meteorites and terrestrial seawater. A recent estimate by the present author, however, suggests that this value is high by an order of magnitude, and some astrophysical implications of a primordial solar D/H ratio of 1.5×10^{-5} are discussed. These are concerned with stellar and galactic evolution, and cosmology. It is unlikely that a detectable deuterium main sequence would exist if the reduced D/H ratio is correct. Furthermore, two related properties of D, the low temperature at which it burns and the difficulty in producing it in significant quantities in the Galaxy, suggest that it might be a sensitive monitor of the evolution of the Galaxy and the universe. (UK)

13104 ROTATING RELATIVISTIC RING. McCrea, W. H. (Univ. of Sussex, Brighton, Eng.). Nature (London); 234: No. 5329, 399-401(17 Dec 1971).

Consideration of a rotating ring sheds light upon the problem of the rotating disk, recently discussed in Nature (228: 272(1970); 230: 13(1971); 230: 197(1971); 232: 548(1971)) by several authors, and shows the disk problem to be more difficult than it appears. (auth)

13105 HYDROSTATIC EQUILIBRIUM AND GRAVITATIONAL COLLAPSE OF RELATIVISTIC CHARGED FLUID BALLS. Bekenstein, Jacob D. (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 8, 2185-90(15 Oct 1971).

The metric corresponding to an arbitrary spherically symmetric distribution of charged perfect fluid is obtained without restricting consideration to the static case, and it is shown that it joins onto the standard Reissner–Nordström exterior solution of Einstein's equations. The Oppenheimer–Volkoff equations of hydrostatic equilibrium are also generalized to the charged case, and their applicability is discussed. Using this formalism, a formula of Christodoulou which splits the mass of a charged black hole into an irreducible part and a reducible electrical part is rederived. Finally, the equations for the gravitational collapse of a charged fluid ball are derived, and some general conclusions are drawn from them. (auth)

13106 GENERAL RELATIVITY AND COSMOLOGY. Proceedings of the International School of Physics, Enrico Fermi, Varenna, Italy, 30th June–12th July 1969. Course XLVII. Sachs, B. K. (ed.). New York; Academic Press Inc. (1971). 402p. $21.00.

Separate abstracts were prepared for fourteen of the fifteen lectures given. (W.D.M.)

For abstracts of individual chapters see: 12911, 13107–13114, 13794, and 13815–13818.

13107 RELATIVISTIC COSMOLOGY. Ellis, G. F. R. (Cambridge Univ., Eng.). Rend. Scu. Int. Fis. Enrico Fermi; 47: 104-82(1971).

An attempt is made to determine a cosmological model that will correctly predict the results of astronomical observations and whose behavior is determined by those physical laws that describe the behavior of matter on scales up to those of clusters of galaxies. Dynamical relations valid in any cosmological model are obtained, and these relations are illustrated by applying them to some particular cosmological models. Observational relations valid for any cosmological model are derived, and as an illustration of the methods used, their application to the standard isotropic cosmological models is given. A broad overall picture of the observable Universe is presented on the basis of recent observations. (W.D.M.)

13108 ASTROPHYSICAL COSMOLOGY. Sciama, D. W. (Cambridge Univ., Eng.). Rend. Scu. Int. Fis. Enrico Fermi; 47: 183-236(1971).

This lecture was intended to complement Ellis's course on relativistic cosmology with the emphasis on observations. Topics covered include the classical period, Robertson–Walker models, the semi-classical period, the modern period, the intergalactic medium, microwave background radiation, molecular measurements, thermal history of the Universe, isotropy of the background, relation to Mach's principle, the helium problem, and high-energy interactions with the blackbody radiation. (W.D.M.)

13109 RELATIVISTIC STARS, BLACK HOLES, AND GRAVITATIONAL WAVES (INCLUDING AN IN-DEPTH REVIEW OF THE THEORY OF ROTATING, RELATIVISTIC STARS). Thorne, K. S. (California Inst. of Tech., Pasadena). Rend. Scu. Int. Fis. Enrico Fermi; 47: 237-83(1971).

A review is presented of recent (post-1965) developments in the theory of relativistic stars and gravitational waves. Emphasis is on nonspherical rotating stars. (W.D.M.)

13110 QUASI-STELLAR OBJECTS: THEIR IMPORTANCE FOR COSMOLOGY AND GENERAL RELATIVITY. Burbidge, G. R.; Burbidge, E. M. (Univ. of California, San Diego). Rend. Scu. Int. Fis. Enrico Fermi; 47: 284-305(1971).

It is shown that, whatever the origin of the redshift, there is strong evidence that very strong gravitational fields are present in quasars and nuclei of galaxies. Thus, they are the best candidates for the study of general relativity in the strong-field approximation. Observational properties of quasars that bear on these questions are discussed. (W.D.M.)

13111 OPTICAL OBSERVATIONS RELEVANT TO COSMOLOGY: HUBBLE DIAGRAM. Burbidge, E. M. (Univ. of California, San Diego, La Jolla). Rend. Scu. Int. Fis. Enrico Fermi; 47: 306-14(1971).

Observational problems in the construction of the Hubble diagram are listed and work by Sandage is reviewed. (W.D.M.)

13112 SOME CURRENT IDEAS ON GALAXY FORMATION. Rees, M. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Rend. Scu. Int. Fis. Enrico Fermi; 47: 315-46(1971).

The interaction between various processes in the hot big-bang model is described, and the extent to which one can understand the occurrence of structure with the characteristically observed scales without artificially choosing the initial conditions with this end in view is discussed. (W.D.M.)

13113 STABILITY OF RELATIVISTIC STAR CLUSTERS. Ipser, J. R. (California Inst. of Tech., Pasadena). Rend. Scu. Int. Fis. Enrico Fermi; 47: 356-8(1971).

The possible existence of relativistic star clusters is discussed, and the gravitational collapse of such clusters is considered. (W.D.M.)

13114 COSMOLOGICAL DENSITY FLUCTUATIONS DURING HADRON STAGE. Kundt, W. (Univ., Hamburg). Rend. Scu. Int. Fis. Enrico Fermi; 47: 365-72(1971).

A short review of Hagedorn's high-energy thermodynamics is given, and its cosmological implications are discussed. (W.D.M.)

Planetary Phenomena

Refer also to abstracts 13487 and 13822.

13115 (CONF-710402-(Vol.1), pp III.17-19) APPLICATION OF NEUTRON SOURCES TO EXTRATERRESTRIAL STUDIES. Trombka, J. I. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The application of neutron sources to extraterrestrial studies can be divided into three major areas: (1) power sources, (2) elemental analysis experiments, and (3) high-gamma-ray-energy calibration sources. The use of neutron sources as power sources is not considered in this review; only the latter two areas of application are considered. The use of neutron–gamma techniques for performing elemental analysis has been studied for a number of years for possible application to geochemical analysis of lunar and planetary surfaces. Up to the present time, no missions have been flown in which such measurements have been carried out, nor are any such missions contemplated for the next few years. Possibilities exist for the use of these techniques from the middle to late 1970's. High-gamma-ray-energy calibration sources have been developed and are being used to calibrate the Apollo 15 and 16 gamma-ray spectrometers. These experiments will measure the emitted gamma-ray spectrum in order to determine the elemental composition of the lunar surface. (auth)

13116 HIGHEST FREQUENCY OF JUPITER'S DECAMETRIC RADIATION. Baart, E. E.; Greener, J. G.; Wulff, A. (Rhodes Univ., Grahamstown, S. Afr.). Astrophys. Lett.; 9: No. 4, 211-13(Nov-Dec 1971).

The position of the satellite Io relative to Jupiter is shown to be correlated with the highest frequency in Jupiter's decametric radiation which is received on Earth. The variation in the highest frequency with sub-Io longitude provides a test for theories of the generation of the radiation. (auth)

13117 ELECTRON COLLISION FREQUENCY IN MARTIAN IONOSPHERE. Agarwal, D. C. (Allahabad Univ., India). Indian J. Phys.; 44: No. 6, 336-8(Jun 1970).

The results for E2-region (Bradbury Layer) collision frequency of the Martian atmosphere are presented. It is observed that for this layer, the collision frequency of electrons with neutral constituents is negligible in comparison with that with positive ions. The E2 region collision frequency is found to be 7.6×10^8 sec^{-1}. (auth)

13118 ENERGETIC ION BURSTS ON THE NIGHTSIDE OF THE MOON. Freeman, J. W. Jr. (Rice Univ., Houston, Tex.). J. Geophys. Res.; 77: No. 1, 239-43(1 Jan 1972).

Recurrent bursts of positive ions are a persistent feature of the data from the Apollo-12 and Apollo-14 Alsep suprathermal ion detectors. Most remarkable is the occasional occurrence of these events when the Alsep is deep in the lunar night. One such series of bursts seen during December 1969 starting approximately 4.7 days before sunrise at the Apollo-12 Alsep site is reported. These bursts have durations ranging up to 14 min and recur with a highly variable frequency. The ions have differential energy spectra with narrow peaks. The peak energies range from 10 to 1250 eV but are found most frequently in the vicinity of 250 to 500 eV. They can be seen when the field of view of the detector looks as close as 16° to the antisolar direction. Average integral fluxes are of the order of 10^6 ions/cm^2 sec ster. Data from the ion-mass analyzer indicate that, unlike some similar events seen on other occasions, these ions have mass per unit charge less than 10 amu/q and hence are probably of solar-wind origin. (auth)

13119 SEARCH FOR X RAYS FROM THE PLANET JUPITER. Hurley, K. C. (Univ. of California, Berkeley). J. Geophys. Res.; 77: No. 1, 46-53(1 Jan 1972).

Actively collimated balloon-borne scintillation counters employing a special phoswich anticoincidence technique were flown a total of 5 times from Palestine, Texas. Jupiter was observed for a total of 133 min, and an upper limit to the flux of x rays present at the observation time is 1.6×10^{-2} x rays/cm^2 sec in the energy range 30 to 100 keV. Three separate calculations are made to estimate the flux of Jovian x rays at the Earth; the first two calculations involve scaling up terrestrial precipitating electron fluxes by factors that depend on the energy intercepted by Jupiter's magnetosphere and the Jovian magnetic-field strength, whereas the third estimate is based on a model of Jovian decametric emission. These estimates range from 10^{-9} to 10^{-1} x rays/cm^2 sec in the energy range 30 to 100 keV. It is concluded that, since there was no decametric emission at the time of the flight and there had been no significant solar activity for several days prior to the flight, no x rays were being generated at the time of the observation. (auth)

13120 MARINER 6 AND 7 ULTRAVIOLET SPECTROMETER EXPERIMENT: IMPLICATIONS OF CO_2^+, CO, AND O AIRGLOW. Stewart, A. I. (Univ. of Colorado, Boulder). J. Geophys. Res.; 77: No. 1, 54-68(1 Jan 1972).

The Mariner 6 and 7 ultraviolet spectrometer experiments ob-

served intense emissions from CO, O, and CO_2^+ in the Martian airglow. Analysis shows that they are excited predominantly by the absorption of solar euv photons by CO_2 and constitute a major energy-loss mechanism for the thermosphere. Models of the thermospheric temperature profile and the airglow layer that demonstrate the effects of neutral chemistry and ionospheric composition are developed. With their aid, the observed CO Cameron-band emission scale height of 19 ± 4½ km is shown to suggest an exospheric temperature of 315 ± 75°K. Consideration of other data suggest a best value of about 350°K. The emissions from CO_2^+ are consistent with a topside ionosphere containing about 30% CO_2^+. The abundance of O necessary to convert the rest to O_2^+ is about 2% at 135 km, in good accord with an independent determination. Within the uncertainties in the excitation efficiencies and in the thermospheric cooling mechanisms, the observations are consistent with the measured electron density. Eddy cooling may be important if the eddy diffusion coefficient is large, but it is difficult to reconcile the heating effects of CO_2 with the small observed airglow scale heights. There is no indication in the data that the ionosphere is modified by the solar wind below 200 km. (auth)

13121 HIGH-FREQUENCY ELECTROMAGNETIC RESPONSE OF THE MOON. Schubert, G. (Univ. of California, Los Angeles); Schwartz, K. J. Geophys. Res.; 77: No. 1, 76-83(1 Jan 1972).

It is shown that the contribution of higher harmonics to the lunar transfer functions for the tangential components of the surface magnetic field is significant at frequencies greater than 0.01 Hz (Apollo-12 and Explorer-35 magnetometer data extend to frequencies as high as 0.04 Hz). The inclusion of the higher harmonics shows that there are two distinct transfer functions corresponding to the components of the tangential surface magnetic field perpendicular and parallel to the direction of the wave vector of the external disturbance forcing the lunar induction. The dependences of these transfer functions on frequency and location are determined. The effects of the higher harmonics can (1) account for a hitherto unexplained feature in the Apollo-12 and Explorer-35 transfer functions, namely the rolloff at high frequencies, and (2) offer a possible explanation for the frequency dependence of the difference between the transfer functions for the two orthogonal components of the surface magnetic field. The harmonic response of a simple current-layer model of the Moon is derived and shown to provide a reasonable fit to the experimental data. (auth)

Atomic and Molecular Physics

Refer also to abstracts 13397 and 14310.

13122 ATOMIC PHYSICS. VOLUME 1. INTRODUCTION TO QUANTUM PHYSICS AND ATOMIC STRUCTURE. Cagnac, B; Pebay-Peyroula, J. C. Paris; Dunod (1971). 295p. (In French).

Experiments are described, and the results are compared with theoretical predictions, for the purpose of establishing the fundamental principles of quantum mechanics on an experimental basis, explaining the essential laws governing the internal structure of atomic systems, and revealing the experimental investigations currently being undertaken in various laboratories and their motivations. The first volume consists of three parts: the wave and the photon; the planetary model and principal quantum number; the kinetic and magnetic moments. (France)

13123 ATOMIC PHYSICS. VOLUME 2. INTRODUCTION TO QUANTUM PHYSICS AND ATOMIC STRUCTURE. Cagnac, B.; Pebay-Peyroula, J. C. Paris; Dunod (1971). 249p.

Experiments are described, and the results are compared with theoretical predictions, for the purpose of establishing the fundamental principles of quantum mechanics on an experimental basis, explaining the essential laws governing the internal structure of atomic systems, and revealing the experimental investigations currently being undertaken in various laboratories and their motivations. The second volume concerns the quantum explanation of atomic structure. The following cases are considered: a single electron without spin; independent electrons in a central potential; kinetic moments and energy levels; the spectroscopy of systems with one or two electrons; atomic magnetism (Zeeman and Paschen–Back effects); the nucleus and the physics of the atom; experimental methods used in studying the physics of the atom. (France)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 13405 and 14291.

13124 (AD-710407) CONVOLUTION ANALYSIS OF ELECTRON IMPACT EXPERIMENTS. Cowperthwaite, Ronald L.; Myers, Howard (McDonnell Douglas Corp., St. Louis, Mo.). 1 Jul 1970. Contract F19628-70-C-0134. 41p. (AFCRL-70-379). NTIS.

Electron-impact experiments are analyzed from the standpoint of the influence of the electron beam energy distribution on the measurements. A generalized electron energy distribution function is formulated. Special cases of this distribution function yield analytical representations of operational electron guns. The energy distribution of the gun is found to strongly affect the salient features of the cross section. A procedure is then developed for unfolding the true cross section from impact measurements by removing the distortion of the electron beam. Comparisons with measured data are presented. The response function for a simple retarded gun is derived. The unfolding equation is found to be a first-order differential equation. This is in strong contrast to the simple accelerated electron gun, which gives an algebraic equation for the unfolding equation. The stability of the integration, with respect to errors in the initial value, is evaluated. The solution is found to be exponentially unstable when forward integration is used, and exponentially stable when backward integration is used. An important practical consequence of the backward integration stability is that it permits estimating the initial value of the true cross section with the folded cross section. (auth) (USGRDR)

13125 (IJS-P-268) SURFACE IONIZATION PHENOMENA INVESTIGATED BY A MASS SPECTROMETRIC METHOD. MEASUREMENT OF ION INITIAL VELOCITIES AND DESORPTION ENERGIES OF IONS AND ATOMS. Zazula, Peter (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Jun 1971. 43p. (In Serbo-Croatian). Dep. NTIS (U. S. Sales Only).

Thesis.

On the basis of solution of the differential equation that describes the nonstationary state of the ionizing surface, the known method for measuring the ion residence times was extended to neutral atoms as well. The method is illustrated by experimental results on the ionization and desorption of sodium on platina. Analysis of the dynamic process of ionization and desorption leads to an expression relating the measured quantities to theoretical parameters. The expressions show that it is possible to measure, by known methods, the desorption energies of ions and atoms only for systems having a metal work function higher than the ionization potential of the adsorbed atoms. For systems having an ionization potential higher than the work function, it is possible to measure only the desorption energies of neutral atoms. Initial velocity-distribution measurements have shown that the distribution is Maxwellian, even for nonstationary desorption processes. Rapid time changes in the ion current were measured by the sampling method, which allows simultaneous data processing with analog converters and registration with slow recorders. Prior to the application of the sampling method to the analyzing system of the mass spectrometer, the ion–optical discrimination of the measuring apparatus had to be calculated. (auth)

13126 (LBL-500, pp 191-204) POLARIZED ELECTRONS AND SOME OF THEIR USES. Hughes, Vernon W. (Yale Univ., New Haven, Conn.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Methods for producing free polarized electrons are described, with emphasis on the photoionization of polarized alkali atoms. Experiments using polarized electrons in atomic, solid-state, and high-energy physics are listed. Parameters for several polarized electron sources are given. (28 figures). (R.W.R.)

13127 RESONATOR WITH ATOMIC OR MOLECULAR BEAM. (to Laboratoire Suisse de Recherches Horlogeres). British Patent 1,257,714. 22 Dec 1971. Priority date 19 Apr 1968, Switzerland.

The resonator described includes a source for producing an atomic or molecular beam, first and second state selectors separated by an interaction zone, means for generating an oscillating magnetic field in the interaction zone, and a detector. The second state selector comprises a dipolar assembly having a magnetic or electrostatic field in which is positioned a metallic member of high magnetic permeability intended to concentrate the lines of force. It is claimed that an increase in intensity by a factor of several hundreds relative to that obtained by known dipole-magnet geometry is obtained by the improved geometry of the second state selector. (A.G.W.)

13128 ONE-DIMENSIONAL MODEL OF RELATIVISTIC ELECTRON BEAM PROPAGATION. Poukey, J. W. (Sandia

Labs., Albuquerque, N. Mex.); Rostoker, N. Plasma Phys.: 13: No. 10, 897-904(Oct 1971).

Numerical and analytic methods were used to investigate the propagation of a relativistic electron beam through a grounded conducting plane into a region that either is vacuum or contains a neutral gas. The one-dimensional model used represents the behavior of real beams whose radius is large compared with c/ω_b (the ratio of the speed of light to the plasma frequency corresponding to the beam density). In the vacuum case, the beam does not propagate but a moving potential well forms, which could provide a mechanism for ion acceleration. When neutral gas is present, the beam propagates with a speed that depends on the rate at which the gas is ionized by collisions with the beam electrons. (auth)

13129 COLLISIONAL X-RAY EXCITATION IN SOLID AND GASEOUS TARGETS BY HEAVY-ION BOMBARDMENT. Lutz, H. O. (Kernforschungsanlage, Juelich, Ger.); Stein, J.; Datz, S.; Moak, C. D. Phys. Rev. Lett.; 28: No. 1, 8-10(3 Jan 1972).

Large differences have been found in the x-ray yields produced by 22.5- and 48-MeV iodine ions incident on solid (Se) and gaseous (Br and Kr) targets. These differences are attributable to the steady-state excitation of the penetrating ion prior to the vacancy-producing collision, and yield information on the state of energetic ions in solids. (auth)

13130 EFFECT OF SURFACE MIGRATION OF NICKEL ATOMS ON THE IONIC COMPONENT OF CATHODE EMISSION FROM TUNGSTEN. Adylov, A. A.; Veksler, V. I.; Reznik, A. M. (Tashkent State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 7, 1651-5(Jan 1972).

Translated from Fiz. Tverd. Tela; 13: No. 7, 1968-72(Jul 1971).

The ionic component of cathode emission from a tungsten target was experimentally investigated at various temperatures and current densities of bombarding ions. The investigated targets were pure tungsten and tungsten with a thin surface film of nickel with a controlled degree of coating θ. The deformation of the experimentally obtained energy spectra of W^+ ions, as a function of change in θ, agree with the spectra that were calculated on the basis that an emitted tungsten atom is scattered by a single nickel atom. The data obtained for θ were used to determine the heat of migration of nickel along the surface of tungsten ($l_m = 2.4$ eV), and the heat of desorption of nickel ($l_d = 7.0$ eV). (auth)

13131 SECONDARY-ELECTRON EMISSION FROM SINGLE CRYSTALS BY A SCANNING METHOD. Morozov, Yu. A.; Osarkov, E. B. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 7, 1721-3(Jan 1972).

Translated from Fiz. Tverd. Tela; 13: No. 7, 2051-2(Jul 1971).

Anisotropy of the secondary electron emission (SEE) characteristics of molybdenum single crystals was studied by a scanning method. The results are compared with the data obtained by measuring the angular characteristics of the secondary emission by rotating the target relative to the primary electron beam. The energy of the primary electrons was varied from 200 to 2000 eV and the orientation of the crystal with respect to the primary beam was also changed. The use of beam amplitude modulation in the recording tube provided a sensitivity of about 0.05% of the measured value. (auth)

13132 POLARISATION OF IONS AND ELECTRONS BY OPTICAL-PUMPING TECHNIQUES. Schearer, L. D. (Texas Instruments Inc., Dallas). pp 87-104 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

It is stated that optical pumping has attained much success in the study of the paramagnetic properties of dilute gases and vapors, atomic collision processes, coherence phenomena, etc., and difficulties previously arising with this technique are discussed. A description is given of the utilization of the strong spin dependence of Penning ionizing collisions between optically oriented metastable He atoms and impurity atoms to induce a net polarization in the ground or excited levels of the impurity ions that are then available for the purpose of radio-frequency spectroscopy. The technique combines the use of a fast flowing afterglow, optical pumping, and Penning collision processes, and is characterized by the production of a high density of highly spin-polarized ions in both their ground and excited states in a field-free region. Headings are as follows: introduction; properties of the flowing afterglow; polarization transfer to ions (spin dependence of Penning reactions; experimental observations); Penning electron polarization; detection of ground-state ion polarization; excited ion resonances in Cd^+ and Zn^+; He^M–He^M collisions—polarized electrons and He^+ ions. 19 references. (UK)

13133 SECONDARY ELECTRON EJECTION FROM METAL SURFACES BY METASTABLE ATOMS. I. MEASUREMENTS OF SECONDARY EMISSION COEFFICIENTS USING A CROSSED BEAM METHOD. Dunning, F. B.; Smith, A. C. H.; Stebbings, R. F. (University Coll., London). J. Phys.; B (London); 4: No. 12, 1683-95(Dec 1971).

A crossed-beam technique was used to determine secondary electron emission coefficients for $He(2^1S)$, $He(2^3S)$, $Ne(^3P_{0,2})$, and $Ar(^3P_{0,2})$ metastable atoms incident with thermal energy on atomically clean cadmium and contaminated stainless steel surfaces. The secondary emission coefficients for the atomically clean surface were in all cases found to be less than 0.5, but for the contaminated surfaces values in excess of 0.5 were measured. Mechanisms are suggested to account for the observed large values. (auth)

13134 SECONDARY ELECTRON EJECTION FROM METAL SURFACES BY METASTABLE ATOMS. II. MEASUREMENTS OF SECONDARY EMISSION COEFFICIENTS USING A GAS CELL METHOD. Dunning, F. B.; Smith, A. C. H. (University Coll., London). J. Phys., B (London); 4: No. 12, 1696-1710(Dec 1971).

Secondary electron emission coefficients for thermal-energy $He(2^1S)$, $He(2^3S)$, $Ne(^3P_{0,2})$, and $Ar(^3P_{0,2})$ metastable atoms incident on a gold surface were measured using an improved gas-cell absorption method. The coefficients for the same metastable species incident on chemically cleaned stainless steel and copper surfaces and on atomically clean cadmium and tungsten surfaces were determined by calibration against the gold surface. The results indicate that rather larger coefficients than those used hitherto should be used for gold surfaces. The implications of the results presented for the measurement of metastable fluxes are examined. (auth)

13135 EQUILIBRIUM CHARGE DISTRIBUTIONS OF C, N, O, AND Ne IN CARBON FOIL. Girardeau, R.; Knystautas, E. J.; Beauchemin, G.; Neveu, B.; Drouin, R. (Univ. Laval, Quebec). J. Phys., B (London); 4: No. 12, 1743-6(Dec 1971).

Equilibrium charge distributions of C^+, O^+, N^+, and Ne^+ beams in carbon foil were measured for incident energies of 1 to 5 MeV. There is consistent agreement with previous work in those regions where there are data in common. Charge state equilibrium is reached in foils at least as thin as 6 $\mu g\ cm^{-2}$. (auth)

13136 ANGULAR AND ENERGETIC DEPENDENCE OF ION-INDUCED ELECTRON EMISSION FROM NIOBIUM AND MOLYBDENUM SINGLE CRYSTALS. Begrambekov, L. B.; Kurnaev, V. A.; Sotnikov, V. M.; Tel'kovskii, V. G. (Moscow Engineering Physics Inst.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 6, 1365-8(Dec 1971).

Translated from Fiz. Tverd. Tela; 13: No. 6, 1631-4(Jun 1971).

A retarding-potential method is used to measure the angular distributions of 5 to 35-eV electrons emitted from the (101) planes of Mo and the (111) planes of Nb bombarded by 15 to 35-keV inert-gas ions. The observed features in the distributions are explained by the emission of electrons that move primarily along close-packed directions in the crystal. It is assumed that the influence of the ion energy and mass on the distributions is related to changes in the energy states of the electrons through changes in the velocities of the bombarding particles. The experimentally determined dependence of the electronic index of reflection on the electron energy in a vacuum, n(E), is somewhat smoother than that computed for free particles. This type of behavior of n(E) can be explained by differences between the dispersion curves in the empty band of the metals studied here and those for free electrons. (auth)

13137 PLURAL SCATTERING OF ELECTRONS IN THE ENERGY RANGE 112 TO 380 keV. Aiginger, Hannes; Gebauer, Harald (Oesterreichische Hochschule, Vienna). Acta Phys. Austr.; 33: No. 2, 127-42(1971). (In German).

The angular distributions obtained after plural scattering of 112-, 180-, 290-, and 380-keV electrons in thin foils of Al, Ag and Pb were measured for angles between 0 and 20°. The foil thicknesses were between 0.101 mg/cm² and 1.670 mg/cm² with mean numbers of collisions between 1 and 13. The experimentally derived angular distributions of the scattered electrons were compared with a numerical computation by Keil, Zeitler, and Zinn based on the Molière theory of plural and multiple scattering and his approximation of the single scattering law. His corrected values of the shielding angle and the mean number of collisions describe the distribution of the scattered electrons better than

the original ones derived from a Born-approximation calculation. The intensity of the remaining unscattered electrons must be calculated with the Born approximation value for the mean number of collisions in order to obtain agreement with the experiment. For values of $\alpha = Z/137$, $\beta > 1$, discrepancies greater than the limits of error occur. (auth)

Atomic and Molecular Properties

Refer also to abstract 14220.

13138 3-BODY ENERGY TERMS IN A QUARTET STATE OF H_3. Brailsford, D. F.; Ford, B. (Univ. of Nottingham, Eng.). Chem. Phys. Lett.; 12: No. 1, 60-1(1 Dec 1971).

Calculations of the 3-body energy term in a quartet ($^4A_2$) state of H_3 (equilateral–triangle nuclear configurations) show a minimum in the 3-body energy for a side length of about 1.3 bohrs. (auth)

13139 MULTIPLET SPLITTING OF THE 4s AND 5s ELECTRONS OF THE RARE EARTHS. Cohen, R. L.; Wertheim, G. K.; Rosencwaig, A.; Guggenheim, H. J. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 5: No. 3, 1037-9(1 Feb 1972).

The multiplet splitting of 4s and 5s electrons of trivalent rare-earth ions was measured by photoelectron spectroscopy. This splitting represents the energy difference between the s-electron spin-up and spin-down final states. (auth)

13140 CONVERGENCE OF MULTIBODY EXPANSIONS FOR SHORT-RANGE INTERMOLECULAR FORCES. A SCF CALCULATION OF He_3 AND He_4 SYSTEMS. Novaro, O. A. (Instituto Mexicano del Petroleo, Mexico City); Beltran-Lopez, V. J. Chem. Phys.; 56: No. 2, 815-19(15 Jan 1972).

The potential-energy surface of He_3 is calculated within the SCF–LCAO–MO approximation to test the pairwise additivity of intermolecular forces at short range. Large nonadditive contributions were obtained at very close distances, but in general, in the neighborhood of the van der Waals well (~5.6 a.u.), they are negligible. However the study of a few He_4 configurations shows that four-body effects can be important enough to question the convergence of many-body expansions. (auth)

13141 THEORETICAL STUDIES OF THE BINDING ENERGY AND GEOMETRY OF THE H_5^+ MOLECULAR ION. Huang, Jantsyu J. (Univ. of Notre Dame, Ind.); Schwartz, Maurice E.; Pfeiffer, Gary V. J. Chem. Phys.; 56: No. 2, 755-8(15 Jan 1972).

The geometry and binding energy of the H_5^+ molecular ion were examined by two different ab initio quantum mechanical variational methods. In the first a configuration-interaction wave function was made from the 10 covalent valence-bond structures that could be constructed from 1s orbitals at the nuclei, each 1s orbital being represented by a five-term Gaussian expansion and having a variable scale factor. For geometries identical or similar to the D_{2d} geometry previously predicted from analogous calculations with cruder basis sets, no stability was found with respect to $H_3^+ + H_2$. Other geometries were examined, especially those arising naturally from the approach of H_3^+ and H_2; however, binding was never greater than a tiny 0.6 kcal/mole. It was thus concluded that the method had failed adequately to describe H_5^+, as it had for H_3^+, and that it is probably unreliable for studying ions with small binding energies. The second method used the SCF MO model with a flexible basis set to account for distortion and polarization. This gave an H_5^+ geometry corresponding to an $H_3^+ \ldots H_2$ complex of overall C_{2v} symmetry, in which the H_2 sits about 3 a.u. from the H_3^+ apex and perpendicular to the H_3^+ plane and to a line extending from the midpoint of the base of the H_3^+, through the H_3^+ apex, and through the H_2 midpoint. The calculated binding energy relative to $H_3^+ + H_2$ is 4.25 kcal/mole. Because formation of such a loose molecular complex from two closed-shell systems should produce very little extra correlation energy in the complex, and because of basis set reasons discussed in the text, these results are believed to be reliable. (auth)

13142 DISSOCIATION ENERGIES OF X $^2\Sigma_u^+$ (He_2^+) AND A $^1\Sigma_u^+$ (He_2). Ginter, M. L.; Brown, C. M. (Univ. of Maryland, College Park). J. Chem. Phys.; 56: No. 1, 672-4(1 Jan 1972).

Possible values for the dissociation limit of A $^1\Sigma_u^+$ (He_2) for various numberings of the stable vibrational levels are presented. Contradictions between values obtained by different investigators are discussed, and possibilities for resolving these contradictions are suggested. (A.G.W.)

13143 ACCURATE CALCULATION OF THE VIBRATIONAL FORCE CONSTANT OF THE HYDROGEN MOLECULE BY VARIATION–PERTURBATION THEORY. Chang, S. Y. (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 56: No. 1, 4-7(1 Jan 1972).

By using the Parr and White perturbation scheme for the diatomic potential energy as a function of internuclear distance, the quadratic force constant k_e of the ground state of the hydrogen molecule is calculated by solving a perturbation equation in which the electronic kinetic energy is the perturbation. The first- and second-order energies in the force-constant expression are calculated by a second perturbation expansion with electron correlation as perturbation. The zeroth-order uncorrelated wave function is determined from the distorted-atoms-in-molecule model. The first- and second-order perturbation equations involving kinetic-energy perturbations are solved exactly. By applying accessible correlation expressions, all of the perturbation energies are evaluated without explicit determination of the correlation wave functions. The value of k_e found is 0.35 to 0.37 a.u., in good agreement with the experimental value 0.368 a.u. (auth)

13144 ENERGY SHIFTS OF K X-RAY LINES FROM TRI- AND TETRAVALENT PRASEODYMIUM. Lee, P. L.; Seltzer, E. C.; Boehm, F. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Lett.; 38A: No. 1, 29-30(3 Jan 1972).

The energy shifts of the $K\alpha_2$, $K\alpha_1$, $K\beta_3$, $K\beta_1$, and $K\beta_2$ X rays from different pairs of trivalent and tetravalent Pr compounds were measured with the Caltech 2-m bent-crystal spectrometer. The results are compared with a relativistic self-consistent-field calculation. It is concluded from a preliminary analysis that approximately 0.5 of a 4f electron charge is transferred to the ligands, the 4f electron charge transfer being chiefly responsible for the chemical shift. From this result an estimate of the change in the electron density at the nucleus is made. (auth)

13145 GROUND-STATE BINDING ENERGIES OF THREE IDENTICAL PARTICLES WHICH INTERACT VIA THREE MUTUAL MORSE POTENTIALS. Kureger, H. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Ger.). Phys. Rev. Lett.; 28: No. 2, 71-4(10 Jan 1972).

Within the framework of Faddeev theory the binding energy of the lowest bound state of three identical particles is calculated. Excluding three-body potentials, the particles are assumed to interact mutually via a two-body Morse potential. Finally, these model calculations are applied to a system formed of three helium atoms. Using a Morse potential fitted to the He–He interaction potential calculated by Bertoncini and Wahl, this calculation predicts a stable triatomic helium molecule with a binding energy of 0.4°K, even though a diatomic helium molecule does not exist for the same well depth. (auth)

13146 MOLECULAR SCREENING IN HELIUM MOLECULAR ION. Wang, C. M.; Musulin, B. (Southern Illinois Univ., Carbondale). Can. J. Chem.; 49: 3406-8(15 Oct 1971).

Variational energy calculations for He_2^+ were performed, and the results were used to evaluate a semi-empirical method for choosing orbital exponents in quantum chemical calculations. (auth) (Canada)

13147 ISOTOPE SHIFTS AND NUCLEAR PHYSICS. Stacey, D. N. (Oxford Univ.). pp 105-11 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

The factors upon which isotope shifts in electronic and muonic atoms depend are discussed. Measurements are reported for Ne, which element affords a useful illustration since optical and electronic x-ray shifts, as well as muonic results, are available for several isotopes. A more general survey of the present situation is then given. The experimental results discussed, together with others such as electron scattering and Coulomb excitation work, are stated to be producing an impressive set of data on the charge distribution of nuclei. 20 references. (UK)

13148 CALCULATION OF THE TAKABAYASI ANGLE FOR THE HYDROGEN ATOM. Quilichini, Paul. Compt. Rend., Ser. B; 273: No. 20, 829-32(15 Nov 1971). (In French).

The irreducible representations of SU(2) are expressed in terms of Pauli algebra. The solutions of the Dirac–Hestenes equation are calculated for the hydrogen atom, and expressions for some field magnitudes, in particular the Takabayasi angle, are deduced. (France)

13149 ANTI-LEVEL CROSSINGS OBSERVED IN n = 3 HYDROGEN LEVELS. Glassmaujean, M.; Descoubes, J. P. (Ecole Normale Superieure, Paris). Compt. Rend., Ser. B.; 273: No. 16, 721-4(18 Oct 1971). (In French).

The Lamb shift of the n = 3 hydrogen level was measured by applying anticrossing techniques to levels mixed by a low static electric field. The value obtained is 315.0 ± 0.9 MHz. (France)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 13679 and 14187.

13150 (CONF-710637-2) POSITRONIUM AND MUONIUM HYPERFINE STRUCTURE AND A NEW DETERMINATION OF α. BETHE-SALPETER BOUND-STATE PERTURBATION THEORY. Owen, David A. (Surrey Univ., Guildford (England). Dept. of Physics). 1971. 24p. (IC-71/140). Dep. NTIS (U. S. Sales Only).

From Seminar on electromagnetic interactions; Trieste, Italy (21 Jun 1971).

Calculation of the positron hyperfine frequency based on the Bethe-Salpeter equation is described briefly. The value obtained was 2.03415×10^5 MHz. The same calculation was then extended to muonium, and from this value it was calculated that $\alpha^{-1} = 137.03617(30)$. (A.G.W.)

13151 MUONIC ATOMS. II. THE APPLICATION OF MUONIC ATOMS TO ISOTOPE AND ISOTONE SHIFTS. Wu, C. S. (Columbia Univ., New York); Wilets, L. Comments At. Mol. Phys.; 2: No. 6, 195-205(Feb-Mar 1971).

It is stated that the main features of muonic isotope shifts are in good agreement with those found in optical and electronic x rays, but there are significant differences in the analysis of data; one of the useful roles of muonic isotope shifts is to provide a normalization and calibration of the optical isotope and isomer shifts. Among matters discussed are: major contributions to optical isotope shifts; extraction of mass and field effects; experimental muonic isotope shifts (^{40}Ca-^{44}Ca, ^{40}Ca-^{42}Ca, ^{40}Ca-^{48}Ca, ^{136}Ba-^{138}Ba); anomalous isotope shifts; correlations with nuclear magic numbers, odd-even staggering; and isotone shifts. 13 references. (UK)

13152 EFFECTS OF NUCLEAR SHAPE ON K^- MESON NUCLEAR CAPTURE. Zieminska, D. (Univ., Warsaw). Acta Phys. Pol.; B2: No. 5, 701-5(Sep-Oct 1971).

The influence of the nuclear deformation on the K^- meson nuclear absorption is discussed for the states 7i, 8k, 9l in dysprosium. It is found that the absorption rate, Γ^{capt}, increases by a factor of 1.5 to 1.7 due to the nuclear deformation. The value of Γ^{capt} is also calculated for the same nucleus on the assumption that a tail of 3 fm has been added to the Fermi distribution of nuclear matter. It is found that Γ^{capt} increases by a factor of 2 as compared with the Fermi distribution without a tail. (auth)

Collision Phenomena

Refer also to abstracts 13279 and 13937.

13153 (IAE-2023) OPTICAL EXCITATION AND IONIZATION OF FAST HYDROGEN ATOMS. Grechukhin, D. P.; Karpushkina, E. I. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 52p. (In Russian). Dep. NTIS (U. S. Sales Only).

The method of optical excitation used here involves the principle that neutral atoms in a beam obtained by proton charge exchange are found in states with the principal quantum numbers n = 1 and n = 2. The beam is irradiated by a stream of quanta, the frequencies of which in the coordinate system of a hydrogen atom correspond to the frequencies of electron transition in excited states with large principal quantum numbers. The analysis of optical excitation utilized two variants: one not taking account of the Stark splitting, and one allowing for the Stark effect in a time-constant electric field. Such electric fields were also examined where the Stark splitting of levels is less than or an order of magnitude of the interval between two outer j-components of the level of the fine-structure level of the atom. Optical excitation analysis discloses the dependency of the n-level population on the radiation density and the time of flight of atoms in a light field. The photoionization cross section is calculated for excited hydrogen atoms ($1 \le n \le 15$) as related to wavelengths of the quanta. The Stark effect is also calculated in the realm of the above-mentioned electric field intensities for the states with $2 \le n \le 10$. (tr-auth)

13154 (NP-19037) ATOMIC BEAM MEASUREMENTS OF SOME SODIUM EXCITATION FUNCTIONS. Gould, G. N. (New South Wales Univ., Kensington (Australia). School of Physics). Jan 1970. 223p. Dep. NTIS (U. S. Sales Only).

A crossed electron-atom beam technique was used to measure the relative excitation functions of the 3^2S-3^2P, 3^2P-5^2D, and 3^2P-6^2S sodium transitions over the energy range from threshold to ~100 eV. The results are compared with existing experimental observations and with the theory. The electron beam was velocity-selected, using a 127° electrostatic selector prior to its interaction with the atomic beam, giving an improvement in energy resolution over previous measurements: a resolution of 0.18 eV (full-width, half-maximum spread) was used for most measurements, selected energy regions being surveyed with an electron beam of 0.07-eV FWHM. No evidence was found for prominent fine structure maxima or minima in the cross section near threshold, as has been observed in e.g., the case of 1s-2p excitation of hydrogen. The polarization of the emitted radiation as a function of incident-electron energy was investigated for the 3^2S-3^2P and 3^2P-5^2D lines, and in the case of the latter transition, evidence was found for a decrease in the polarization near threshold. (auth) (Australia)

13155 (ORO-3349-8) RADIATION INDUCED LUMINESCENT PROCESSES IN GASES. Final Report. Llewellyn, J. A.; Glick, R. E.; Johnson, Robert M. (Florida State Univ., Tallahassee). 10 Sep 1971. Contract AT(40-1)-3349. 69p. Dep. NTIS.

A pulsed system for observing relationships in excitation is described. Helium luminescence produced by 500- to 5000-eV electrons was studied; notable effects of excitation transfer were found when the gas pressure was raised from 10^{-4} to a few times 10^{-3} torr. The basic semi-empirical methods of Green were used to examine excitation and secondary electron production. (L.M.T.)

13156 EXCITATION OF THE RADIATION OF THE OH RADICAL AND DETERMINATION OF THE EXCITATION CROSS SECTION OF ITS BANDS IN THE ULTRAVIOLET REGION. Sushanin, I. V.; Kishko, S. M. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 3, 315(Mar 1971).

Translated from Opt. Spektrosk.; 30: No. 3, 580(Mar 1971).

The radiation resulting when a beam of water molecules was excited by an intersecting beam of electrons was analyzed. Detection of the Balmer lines of atomic hydrogen as well as the $(0 \rightarrow 0)$ and $(1 \rightarrow 0)$ bands of the ultraviolet system of OH confirmed that the predominant process in the collision is $H_2O + e \rightarrow OH^* + H^* + e$. The maximum excitation cross sections for the $(0 \rightarrow 0)$ and $(1 \rightarrow 0)$ bands occur at 16 eV and are 4.1×10^{-19} and 8.6×10^{-21} cm^2, respectively. At higher energies of the exciting electrons, the excitation cross sections slowly decrease. (A.G.W.)

13157 GENERAL METHOD FOR ORIENTING NUCLEI IN ATOMS WITH $^1S_0$ GROUND STATES. Mitchell, Jerry K.; Fortson, E. Norval (Univ. of Washington, Seattle). Phys. Rev. Lett.; 28: No. 1, 5-7(3 Jan 1972).

Nuclei were oriented in free Cd atoms in a He buffer gas by an indirect process involving optical pumping of Rb atoms and subsequent transfer of orientation via Cd^+ ions to Cd atoms by exchange collisions. The method may be used to orient a sizable density of any $^1S_0$ atomic system. Applications include studies of parity-nonconserving nuclear γ-decay asymmetries as well as magnetic-moment measurements. (auth)

13158 CLASSICAL AND QUANTUM REACTION PROBABILITIES AND THERMAL RATE CONSTANTS FOR THE COLLINEAR H + H_2 EXCHANGE REACTION WITH VIBRATIONAL EXCITATION. Bowman, J. M.; Kuppermann, A. K. (California Inst. of Tech., Pasadena). Chem. Phys. Lett.; 12: No. 1, 1-4(1 Dec 1971). (CALT-767-P-4-87).

Classical trajectory calculations for the collinear H + H_2 exchange reaction were performed using the same potential energy surface previously adopted for exact quantum mechanical calculations. Reactions of both ground-state and vibrationally excited-state reagent were considered, over a relative kinetic-energy range sufficient to produce vibrational excitation of products. At energies close to threshold the classical and quantum mechanical reaction probabilities differ sufficiently to cause a major difference in the corresponding thermal rate constants at low temperatures. Effective reaction thresholds differ by 0.07 eV for ground-state and 0.09 eV for excited-state reagent. At energies substantially above threshold the quantum reaction probabilities oscillate around the corresponding classical ones. However, some classical curves also show oscillatory behavior, suggesting caution

in the assignment of oscillations in the quantum curves to quantum effects. (auth)

13159 SLOW ELECTRON POLARIZATION IN ELASTIC SCATTERING BY ALKALI METAL ATOMS. Drukarev. G. F.; Ob'edkov, V. D. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 61: No. 2, 534-6(Aug 1971). (In Russian).

Polarization of an electron beam as a result of exchange scattering by oriented alkali metal atoms is considered. At low energies the polarization magnitude depends on the relation between the scattering lengths in the singlet and triplet states. Because of a favorable relation between the scattering lengths, almost complete polarization is attained for Li and Na atoms. With increase of energy, when the angular distribution becomes anisotropic, almost complete polarization (≈100%) is attained for those electron energy values that correspond to a minimum of the elastic scattering differential cross section. Numerical values for all alkali metal atoms are presented for regions of considerable polarization and collision energies up to 2 eV. (auth)

13160 ABSOLUTE VALUES OF THE ELECTRON IMPACT IONIZATION CROSS SECTIONS FOR MAGNESIUM, CALCIUM, STRONTIUM, AND BARIUM. Vainshtein, L. A.; Ochkur, V. I.; Rakhovskii, V. I.; Stepanov, A. M. (Lebedev Inst. of Physics, Moscow. Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 61: No. 2, 511-19(Aug 1971). (In Russian).

The absolute values of the electron-impact ionization cross sections of alkaline earth metals are measured for ionizing electron energies ranging from the ionization threshold up to 200 eV. By increasing the sensitivity of the ionization-current measurements and employing a new method for recording the concentration of neutral atoms in the atomic beam, the absolute accuracy of the ionization cross section values can be made to exceed that of previous investigation. With increase of atomic number the absolute values of the ionization cross sections increase and the appearance of two peaks is indicated. Theoretical calculations carried out in the Born and classical binary approximations yield good agreement with the experiments. (auth)

13161 ROTATIONAL EXCITATION OF ION–MOLECULE REACTION PRODUCTS: COMPARISON OF THE STATISTICAL PHASE-SPACE MODEL WITH EXPERIMENT. Moran, T. F.; Fullerton, D. C. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys.; 56: No. 1, 21-7(1 Jan 1972).

The statistical phase-space theory of chemical reactions was used to compute vibrational and rotational distributions of N_2^+ formed in thermal reactions of rare-gas ions with nitrogen. Recent spectroscopic data were used to estimate the rotational- and vibrational-state populations of N_2^+ from these bimolecular interactions. Experimental product state distributions compare favorably with those computed from the statistical phase-space treatment for thermoneutral or slightly exothermic reactions; however, discrepancies are observed between theory and experiment for moderately exothermic reactions. (auth)

13162 LOW-RESOLUTION STUDY OF THE INELASTIC CONTINUUM OF N_2. Tisone, Gary C. (Sandia Labs., Albuquerque, N. Mex.). J. Chem. Phys.; 56: No. 1, 108-12(1 Jan 1972).

The energy-loss cross section for 500-eV electrons incident on N_2 in the energy-loss range 30 to 110 eV was studied in the angular range 10° to 30°. This region of the ionized continuum of N_2 was studied with an energy resolution ($\Delta\epsilon/\epsilon$) of 1.5% and an angular resolution of about 1.5°. The contribution of the differential cross section to the total energy-loss cross section was found to be significant. (auth)

13163 THEORY OF SEMICLASSICAL TRANSITION PROBABILITIES (S MATRIX) FOR INELASTIC AND REACTIVE COLLISIONS. III. UNIFORMIZATION USING EXACT TRAJECTORIES. Marcus, R. A. (Univ. of Illinois, Urbana). J. Chem. Phys.; 56: No. 1, 311-20(1 Jan 1972).

A canonical transformation of coordinates in Part I is made using exact trajectories. The transformation tends to uniformize all coordinates including that for the radial motion, thus removing the singularities in the simple semiclassical exponential wave function in typical cases. The new coordinates are "time" and certain constants of the motion. A symmetrical choice for the transformation then yields an integral expression for the S matrix satisfying the principle of microscopic reversibility. Topics discussed include semiclassical unitary transformations and time-reversal properties of action-angle variables and of semiclassical wave functions. Applications and numerical tests of the integral expression for S_{mn} are in progress. (auth)

13164 SEMICLASSICAL TRANSITION PROBABILITIES FOR ATOM–ATOMIC-OSCILLATOR COLLISIONS WITH MORSE POTENTIAL INTERACTION. LaBrecque, R. J.; Morse, R. I. (Clark Univ., Worcester, Mass.). J. Chem. Phys.; 56: No. 1, 546-8(1 Jan 1972).

Semiclassical (ITFITS) calculations of the transition probabilities for a collinear collision of helium with a tungsten atomic oscillator are compared with quantum mechanical results and found to be in good agreement. The appreciable magnitude of multiple quantum transition probabilities is noted. (auth)

13165 VELOCITY DEPENDENCE OF IONIZATION OF Ar, Kr, AND Xe ON IMPACT OF METASTABLE NEON ATOMS. Tang, S. Y.; Marcus, A. B.; Muschlitz, E. E. Jr. (Univ. of Florida, Gainesville). J. Chem. Phys.; 56: No. 1, 566-72(1 Jan 1972).

Measurements of the velocity dependence of the total ionization cross section of argon, krypton, and xenon on impact of thermal-energy metastable neon (Ne*) atoms were made using a velocity-selected beam of the metastable atoms. The composition ($^3P_2/^3P_0$ ratio) of the Ne* atomic beam was measured using an inhomogeneous-field deflecting magnet and found to be about 5/1, assuming equal detection efficiency for the two metastable species. The ionization measurements were of sufficient precision to allow simultaneous determination of both the secondary-electron-ejection efficiency and the cross section. The secondary-electron-ejection efficiency from an argon-covered gold surface on impact of metastable neon atoms was found to be 0.27 ± 0.14. In the relative velocity range investigated (g = 320 to 1700 m/sec) the cross section Q was found to vary as g^{-m} below g = 650 m/sec and to rise at higher relative velocities. The value of m obtained is 0.622 for Ne*–Ar, 0.728 for Ne*–Kr, and 0.874 for Ne*–Xe. A simple semiempirical model based on a two-state impact-parameter treatment is used to fit the experimental results at low velocities. The model indicates that the interaction leading to ionization is short-ranged. (auth)

13166 CALCULATION OF ROTATIONAL AND VIBRATIONAL TRANSITIONS FOR COLLISION OF AN ATOM WITH A ROTATING VIBRATING DIATOMIC OSCILLATOR. Eastes, Walter; Secrest, Don (Univ. of Illinois, Urbana). J. Chem. Phys.; 56: No. 1, 640-9(1 Jan 1972).

A practical method is presented for computing the T-matrix elements for a rotating, vibrating oscillator. A simple model is used, which approximates the features of the He–H_2 system. It is found that the rigid-rotor approximation is in error even at energies well below the threshold for vibrational excitation. For computation of rotational transitions from the ground to the first accessible excited rotational state, many of the excited rotational transitions may be neglected but some of the excited vibrational transitions must be included. At high energies, it is shown that for any particular transition many of the states not strongly coupled to the states involved in the transition may be neglected. It is found that the computation of T-matrix elements for vibrational transitions in the presence of rotational transitions is not prohibitively time consuming. In computing the total cross section it is shown that a calculation including only the ground state gives remarkably good results. (auth)

13167 CLASSICAL LIMIT OF FREDHOLM THEORY FOR ELASTIC AND INELASTIC SCATTERING: INABILITY OF PHASE SPACE INTEGRALS TO DESCRIBE INELASTIC TRANSITIONS. Miller, William H. (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 2, 745-8(15 Jan 1972).

Using a classical phase space integral to approximate certain quantum mechanical operations, the classical limit of the Fredholm determinant for a general multichannel scattering system is derived. This statistical form of the classical limit of scattering is found to give exactly the same "classical S matrix" for the case of potential scattering as does a dynamical treatment of the classical limit. For inelastic scattering, however, the classical S matrix that results from this Fredholm determinant is only an approximation to that obtained by exact classical dynamics. Reasons for this failure of the statistical version of the classical limit for inelastic scattering are discussed. (auth)

13168 ENERGY-DEPOSITION FUNCTIONS IN MASS SPECTROMETRY. Meisels, G. G.; Chen, C. T.; Giessner, B. G.; Emmel, R. H. (Univ. of Houston, Tex.). J. Chem. Phys.; 56: No. 2, 793-800(15 Jan 1972).

Methods for the evaluation of internal energy distribution functions resulting in ions from impact of energetic electrons are examined and their shortcomings are analyzed. It is shown that energy-deposition functions can be estimated from photoelectron spectra and photoionization cross sections if the Bethe–Born

treatment of collisions is employed, but allowance for autoionization and multiple ionization processes is not possible. Deposition functions are calculated for methane, ethane, and ethylene. Mass spectra obtained by folding the functions into breakdown graphs are in reasonable agreement with experimental fragmentation patterns for 70-eV electrons. (auth)

13169 ABSOLUTE GENERALIZED OSCILLATOR STRENGTHS FOR THREE TRANSITIONS IN THE MERCURY SPECTRUM. Skerbele, Ausma; Lassettre, Edwin N. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 56: No. 2, 845-50(15 Jan 1972).

Generalized oscillator strengths were measured for the $6^1S_0 \rightarrow 6^3P_1$, $6^1S_0 \rightarrow 6p'^3P_1$, and $6^1S_0 \rightarrow 7p'^1P_1$ transitions in mercury at 500-eV electron kinetic energy and scattering angles $\theta = 2°$ to 7°. These measurements have been put on an absolute basis using previously determined generalized oscillator strengths [J. Chem. Phys., 52: 2708(1970)] for the $6^1S_0 \rightarrow 6^1P_1$ transition. These experimental data were extrapolated to $(\Delta P)^2 = 0$ to obtain the following limiting oscillator strengths: $6^1S_0 \rightarrow 6^3P_1$, $f_0 = 0.0285 \pm 0.0035$; $6^1S_0 \rightarrow 6p'^3P_1$, $f_0 = 0.704 \pm 0.070$; $6^1S_0 \rightarrow 7p'^1P_1$, $f_0 = 0.067 \pm 0.009$. (auth)

13170 ENERGY TRANSFER IN MONOCHROMATICALLY EXCITED HYDROGEN ($B\,^1\Sigma_u^+$). I. EXCITATION PROCESSES, ELECTRONIC QUENCHING, AND VIBRATIONAL ENERGY TRANSFER. Fink, Ewald H.; Akins, Daniel L.; Moore, C. Bradley (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 2, 900-15(15 Jan 1972).

Excitation of HD molecules into specific vibrational and rotational levels of the $B\,^1\Sigma_u^+$ electronic state by absorption of the 1048 and 1066 Å argon resonance lines was studied under various experimental conditions by observing the steady-state fluorescence spectra of the ($B\,^1\Sigma_u^+ \rightarrow X\,^1\Sigma_g^+$) Lyman bands. Strong excitation of the ($v' = 3$, $J' = 2$), ($v' = 5$, $J' = 2$), and ($v' = 6$, $J' = 5$) levels was achieved. The HD ($B\,^1\Sigma_u^+ \rightarrow X\,^1\Sigma_g^+$) electronic fluorescence from $v' = 3$ was found to be quenched by HD, ^{3}He, ^{4}He, and Ne with effective collision cross sections of 79, 8.8, 9.9, and 3.5 Å^2 at 297°K. Vibrational energy transfer processes HD ($B\,^1\Sigma_u^+$; $v' = 3$, J') + M → HD ($B\,^1\Sigma_u^+$; $v' = 2$, $J' + \Delta J'$) + M + ΔE were studied for the collision partners ^{3}He, ^{4}He, and Ne. Large effective cross sections of 0.89, 0.76, and 0.81 Å^2 were found at 303°K. Rotationally resolved spectra for Ne show that vibrational energy is transferred into both rotation and translation. All energetically accessible values of $\Delta J'$ were observed. On the average one-half of the vibrational energy was transferred into rotation. (auth)

13171 APPLICATION OF FADDEEV AND WATSON TECHNIQUES TO ATOMIC COMPOSITE-PARTICLE PROBLEMS. Chen, Joseph C. Y.; Chung, Kwong T.; Mizuno, Junya (Univ. of California, San Diego, La Jolla). J. Chem. Phys.; 56: No. 2, 951-8(15 Jan 1972).

The techniques of Faddeev three-body theory and Watson multiple-scattering and final-state interaction theories are applied to atomic problems involving more than three particles. The use of large mass disparity inherent in the atomic and molecular systems permits considerable simplification of the problem. Problems explicitly considered are the three-electron atomic and molecular problems, the collision of three composite particles, and the problem of electron scattering by polyatomic molecules. Application of the present method to the open-channel resonance problems in electron–molecule systems is investigated in connection with the calculation of the adiabatic complex potential for the constituent atom–ion interaction by tracing the trajectory of the electronic resonance pole as a function of the internuclear separation. (auth)

13172 ION CYCLOTRON RESONANCE EXPERIMENTS. Bloom, M. (Univ. of British Columbia, Vancouver). pp 127-40 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

The various applications of ion cyclotron resonance (ICR) are mentioned, and a recent technique for the performance of ICR experiments is discussed that has given rise to novel applications, especially in the field of charge-exchange reactions. This new technique involves the method of double resonance, and it exploits two consequences of the interaction between ions and electromagnetic fields when ICR is satisfied; not only does the absorption of energy from the rf electric field facilitate the detection of ICR, but also the ICR condition enables the preparation of ions in a narrow controllable energy range. The ICR signal intensities of ions may be studied by monitoring the power absorption of an ICR spectrometer tuned to the cyclotron resonance frequencies, and the dependence of the signal intensities on a large number of factors is discussed. Reference is made to a high-sensitivity ICR spectrometer, called a Syrotron, that uses a marginal oscillator of the type commonly used in nuclear magnetic resonance; it was designed to exploit the potential of the double resonance method and has been used in the study of ion–molecule reactions in dilute gases. Some of the novel features of the ICR techniques of special interest to chemists are described, together with some of the advantages of the technique from the standpoint of future applications in atomic physics. 24 references. (UK)

13173 COINCIDENCE TECHNIQUES IN SCATTERING. Ehrhardt, H. (Univ., Mainz). pp 141-54 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

Although coincidence techniques have been used in nuclear physics for many years, they have been introduced in atomic scattering physics only recently, the reason being mainly the low detection efficiency for low-energy electrons, photons, ions or neutrons used or produced in atomic collisions. Some fundamental problems in atomic physics have, however, already been attacked with this technique. A description is given of the experimental techniques and typical measurements, including time measurements, separation of processes, full scattering kinematics, and differential cross sections. 21 references. (UK)

13174 HIGH-RESOLUTION MOLECULAR BEAM SCATTERING EXPERIMENTS AT THERMAL ENERGIES AND THE DETERMINATION OF INTERMOLECULAR POTENTIALS BY DIRECT INVERSION OF THE SCATTERING DATA. Pauly, H. (Max-Planck-Institut, Goettingen, Ger.). pp 155-69 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

It is stated that the high energy resolution and accuracy obtained in recent molecular-beam scattering experiments has opened up new possibilities for the determination of intermolecular potentials from scattering data. A brief survey is given of the general behavior of the elastic differential and total scattering cross sections, together with some examples of recent experimental results that show the accuracy achieved, followed by efforts directed towards the problem of finding a practical solution of the so-called inversion problem, that is, the problem of how the potential can be determined directly from the experimental data. Both the differential cross section and the velocity dependence of the total cross sections were calculated for these potentials. The agreement between calculated and experimental cross sections was very good, and it seems that this method of inversion is very useful for the interpretation of high-resolution atom–atom scattering data, provided that the potential well depth is large enough. 23 references. (UK)

13175 THREE-PARTICLE PROBLEM IN ATOMIC PHYSICS. Gerjuoy, E. (Univ. of Colorado, Boulder). pp 271-88 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

The complexities and subtleties of the three-particle problem in atomic physics are discussed, with emphasis on recent progress, especially in areas bearing on present unresolved questions. The particles are considered structureless and their interactions purely electrostatic, and discussion is limited to systems of three particles obeying the so-called zero-order Hamiltonian and associated with the special characteristics of Coulomb forces. Customarily relied on mathematical procedures often break down for collisions under Coulomb forces; on the other hand, however, since these forces are simple in form as well as long range, normally unattainable mathematical simplifications are possible. Illustrative applications are discussed. Among matters discussed are: electron–hydrogen scattering; Glauber calculations; threshold ionization; and Faddeev equations. 38 references. (UK)

13176 PHASE-SHIFT ANALYSIS OF ELECTRON–ATOM SCATTERING. McDowell, M. R. C. (London Univ.). pp 289-306 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

The phase-shift analysis technique is outlined in terms of a minimized chi-squared procedure with nonlinear constraints. Procedures for aiding convergence and error analysis are reviewed. The technique is illustrated with reference to electron–helium elastic scattering, and some additional results are presented. It is suggested that the Frost–Phelps (Phys. Rev., 136A:

1538 (1964)) values of the diffusion cross section are superior, in terms of a phase-shift analysis, to those obtained by Crompton, Elford, and Jory (Aust. J. Phys., 20: 369 (1967)). A scattering length of $1.180 \pm 0.005\ a_0$ for elastic electron–helium scattering is obtained from analysis of experimental data. 32 references. (auth)

13177 SLOW COLLISIONS OF POSITRONS IN GASES. Massey, H. S. W. (University Coll., London). pp 307-43 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

It is stated that considerable interest attaches to the study of the rates of slow collision processes in gases that involve such particles as positrons, antinucleons, and the strange particles. Such particles, either because of the sign of their charge or their mass, can be expected to behave in gaseous collisions in rather different ways from electrons and neutral or ionized atoms and molecules. It is a very severe test of an approximate theory of scattering of slow electrons by atoms that it should be immediately applicable to positrons by merely changing signs. If experimental information about positron collisions can, however, be obtained it would be worth while to test the available theory of electron scattering and, if necessary, extend it so as to be capable of interpreting the observed behavior of positrons. At first sight it would seem unlikely that much could be done experimentally to determine cross sections for slow positron collisions, because available positron fluxes are so small and also because the lifetime of a positron against annihilation by an electron is also very small. Because, however, of the annihilation process, which produces γ rays of sufficient energy to be detected in coincidence counters, the lifetimes of individual positrons may be determined. Many collisions with gas molecules can occur before annihilation, and by observation of the lifetime as a function of age for positrons in a gas under different conditions a large amount of useful information can be obtained about collision rates. Information may also be obtained from details of the annihilation events, and it is even possible that time-of-flight techniques might be employed to obtain direct information about total cross sections for positrons in different gases as a function of positron velocity. Headings are as follows: annihilation of free positrons; positronium; life history of a positron in a gas; positronium formation in the Öre gap; experimental work on cross sections for collision of free positrons with neutral gas atoms and molecules; delayed coincidence annihilation spectra and their analysis; effect of electric fields on Ps formation; angular correlation measurements; theory of collisions of slow positrons with atoms and its application to observed data; collisions with H atoms; zero- and higher-order phase shifts; collisions with He atoms; momentum-transfer cross section; effective number of annihilation electrons; experimental results on delayed annihilation of free positrons in He, argon, and molecular gases. 24 references. (UK)

13178 EXCITATION OF Mg^+ BY ELECTRON COLLISIONS. Blaha, M. (Goddard Space Flight Center, Greenbelt, Md.). Astron. Astrophys.; 16: No. 3, 437-42(Feb 1972).

The Mg II resonance doublet at $\lambda 2800$ represents a suitable diagnostic tool for the study of physical conditions in the solar chromosphere. The interpretation of intensities and line profiles requires the knowledge of all electron collision cross sections, which can affect directly or indirectly the population of upper levels of the doublet. For this purpose, collision cross sections for transitions between levels 3s, 4s, 5s, 6s, 3p, 4p, 5p, 3d, 4d, 5d were calculated in the unitarized Coulomb–Born approximation without exchange. For the 3s–3p and 3s–3d transitions the results were in a good agreement with the close-coupling calculations of Burke and Moores (1968). (auth)

13179 RETARDATION EFFECTS IN VERY LOW-ENERGY HELIUM–HELIUM SCATTERING. Konrady, John; Sucher, Joseph (Cambridge Univ., Eng. Univ., Paris). Phys. Rev. Lett.; 28: No. 2, 74-6(10 Jan 1972).

The elastic differential and total helium–helium scattering cross sections are computed at very low energies. Retardation effects, which are accurately taken into account by using the arc tangent approximation to the Casimir–Polder potential, are shown to contribute several percent to the cross sections. (auth)

13180 ELECTRONIC CROSS SECTIONS AND MACROSCOPIC COEFFICIENTS. VOLUME 2. METALLIC VAPOURS AND MOLECULAR GASES. Laborie, P.; Rocard, J. M.; Rees, J. A. Paris; Dunod (1971). 348p. (In French and English).

A table of electron cross sections and macroscopic coefficients is presented. This book accompanies a first volume published in 1968, which contains data on hydrogen and rare gases (atomic and molecular levels, elastic and inelastic cross sections, excitation, attachment, dissociation, ionization and momentum-transfer cross sections, and macroscopic coefficients). This second volume contains data corresponding to metallic vapors and molecular gases (alkali metals, Hg, various metals, nitrogen, oxygen, water vapor, CO_2, CO, nitrogen oxides, air, halogens and their compounds, organic vapors, and certain other substances). Some experimental values for the coefficients of attachment are included. (France)

13181 EVALUATION OF A COULOMB INTEGRAL FOR PARTICLE SCATTERING. Schulz, M. (University Coll., London. Univ., Mainz). J. Phys., B (London); 4: No. 11, 1476-81(Nov 1971).

A six-dimensional integral in the coordinate space of the particles 1 and 2, containing in the integrand the term $1/|r_1 - r_2|$ and exponential and Coulomb functions of both particles, is transformed into a double integral in the complex plane, and then integrated numerically. (auth)

13182 VIBRATIONAL ENERGY TRANSFER IN THE HYDROGEN MOLECULE–HELIUM ATOM SYSTEM. Shin, Hyung Kyu (Univ. of Nevada, Reno). J. Phys. Chem.; 75: No. 26, 4001-11(23 Dec 1971).

Vibrational energy transfer in H_2 + He is studied by use of the accurate a priori interaction potential. An expression for the vibrational transition probabilities is obtained by solving the Schroedinger equation for the perturbed oscillator states. The expression explicitly shows the dependence of the transition probability on molecular orientations, oscillator anharmonicity, and multiquantum transitions. Detailed numerical study for the $0 \rightarrow 1$ vibrational transition in the electron-volt range is carried out to show the dependence of the transition probability on the relative collision energy and the orientation angle. At higher energies, the introduction of the anharmonicity correction decreases the vibrational transition probability by large factors. The temperature dependence of the transition is also discussed with the angle and energy-averaged transition probability. Vibration–rotation energy transfer is not considered, but the amount of energy transfer to the anharmonic oscillator is calculated as a function of the initial orientation angle. (auth)

13183 SOME RECENT ADVANCES IN THE CALCULATION OF ELECTRON–ATOM COLLISION CROSS SECTIONS. Burke, P. G. Comments At. Mol. Phys.; 3: No. 2, 31-45(Dec 1971-Jan 1972).

Some of the computational methods that have been used to calculate electron–atom cross sections are reviewed. The energy range is divided into three regions; low energies $V_e \approx V_a$ (V_e = velocity of incident atomic electron, V_a = velocity of interacting atomic electron), intermediate energies $V_a \lesssim V_e \lesssim$ few V_a, and high energies $V_e \gtrsim$ few V_a. The physical processes taking place and the computational methods used for each are discussed. In the low-energy region the bound principles that have been derived and the close coupling involved are examined, and numerical solutions of the integrodifferential equations are given. For applications in the intermediate and high energy ranges the Born, the Glauber, and the pseudostate approximations are considered. (UK)

13184 CHARGE EXCHANGE IN HYDROGEN ATOM COLLISIONS. Janev, R. K. (Boris Kidric Inst., Belgrade); Salin, A. J. Phys., B (London); 4: No. 12, L127-8(Dec 1971).

The continuum-distorted-wave method is applied to the calculation of the cross section for the production of H^- by electron capture in H–H collisions. The energy range is 5 to 70 keV. The theoretical results are compared with the experimental results of McClure (1968). (UK)

13185 CHARGE EXCHANGE BETWEEN PROTONS AND ATOMIC HYDROGEN: COMPARISON BETWEEN THEORY AND EXPERIMENT. Salin, A. (Univ., Bordeaux). J. Phys., B (London); 4: No. 12, L125-7(Dec 1971).

The continuum-distorted-wave method is used to calculate cross sections for electron capture by protons in atomic hydrogen in the energy range 50 to 400 keV. The theoretical results are compared with the experimental ones and the agreement is seen to be very satisfactory. (auth)

13186 VALIDITY OF PRADHAN'S IMPULSE APPROXIMATION FOR HIGH-ENERGY CHARGE-TRANSFER PROCESSES. Urata, N.; Watanabe, T. (Tokyo Univ.). J. Phys., B (London); 4: No. 12, L121-5(Dec 1971).

It has been considered that Pradhan's impulse approximation is not valid for $H^+ + H \rightarrow H + H^+$ in the energy range above 200 keV. However, it is found that this discrepancy comes from simple numerical errors and Pradhan's approximation shows proper energy dependence in the high-energy limit as well as absolute values. (auth)

13187 ALGEBRAIC EQUATIONS FOR CROSS SECTIONS FOR EXCITATION OF H ATOMS TO np OR nd STATES BY FAST PROTONS. Khandelwal, G. S.; Shelton, J. E. (Old Dominion Univ., Norfolk, Va.). J. Phys., B (London); 4: No. 12, L109-12(Dec 1971).

Simple algebraic equations for cross sections for excitation by fast protons of H atoms to np or nd states were obtained. The equations are applicable for incident energies not less than 25 keV. (auth)

Atomic Theory

Refer also to abstracts 13145, 13479, and 13743.

13188 (BLG-453) MEDOP: FORTRAN-IV PROGRAM FOR CALCULATING MATRIX ELEMENTS OF ONE-BODY OPERATORS BETWEEN PROJECTED HARTREE-FOCK FUNCTIONS. Depuydt, H.; Schotsmans, L.; Bouten, M.; Bouten-Denys, M. C. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Feb 1971. 28p. (In Dutch). Dep. NTIS (U. S. Sales Only).

A computer program for calculating matrix elements of one-body operators between projected Hartree-Fock functions is described. The most general operator is of the form $T_{\lambda\mu} = \Sigma_{i=1}^{A} t_{\lambda\mu}(\vec{r}_i) [B_1 + B_2 \sigma_z(i)] [B_3 + B_4 \tau_3(i)]$ where $t_{\lambda\mu}(\vec{r})$ is a fairly general tensor operator of rank λ which depends on the spatial coordinate $\vec{r}$ only. (auth)

13189 CASIMIR CHECK FOR THE ALGEBRAIC MATRICES OF THE CONFIGURATION $(d + s)^n$ p. Roth, Charles. J. Res. Nat. Bur. Stand.; 75B: No. 1-2, 31-45(Jan-Jun 1971).

By using the eigenvalues of the Casimir operator for the group SU_3, checking parameters were obtained for 12 electrostatic interaction matrices of the configuration $(d + s)^n$p. (auth)

13190 MULTICONFIGURATION WAVE FUNCTIONS OBTAINED BY APPLICATION OF THE GENERALIZED BRILLOUIN THEOREM. Grein, F.; Chang, T. C. (Univ. of New Brunswick, Fredericton). Chem. Phys. Lett.; 12: No. 1, 44-8(1 Dec 1971).

Wave functions that are singly excited with respect to a given multiconfiguration wave function in the sense of the generalized Brillouin theorem are formed and the extended configuration-interaction problem is solved by variation or perturbation methods. After that the orbitals are properly contracted and the process is repeated until it converges. Computational examples are given for the atoms He, Li and Be, involving pair excitation, spin-projected Hartree-Fock and all-single-excitation type wave functions. (auth)

13191 EFFECTIVE PRINCIPAL QUANTUM NUMBERS OF VALENCE ATOMIC ORBITALS. Cusachs, L. C.; Aldrich, H. S. (Tulane Univ., New Orleans). Chem. Phys. Lett.; 12: No. 1, 197-8(1 Dec 1971).

Analysis of radial moments of Hartree-Fock atomic orbitals shows that their shape near the radial maximum implies an effective principal quantum number that remains small even for heavier elements. (auth)

13192 DETERMINATION OF INTERATOMIC POTENTIALS. Dyne, R. J. (Univ. of Queensland, Brisbane). Proc. Astron. Soc. Aust.; 2: No. 1, 38-40(Jul 1971).

An interaction potential V(r) is chosen as a combination of an exponential repulsive part and an attractive potential thus: $Ae^{-2r} - C_6 r^{-6}$ where C_6 is the van der Waals constant. Potential parameters for Kr-He and Kr-Ne are obtained. A region of maximum contribution to width and shift is demonstrated. (Australia)

13193 COMMENT ON "HYBRID GAUSSIAN-TYPE ORBITAL. A TEST WITH THE HYDROGEN ATOM". Goodfriend, P. L. (Univ. of Maine, Orono); Brownstein, Kenneth R.; Katriel, J.; Adam, G.; Power, James D. J. Chem. Phys.; 56: No. 2, 1016-17(15 Jan 1972).

The validity of the results obtained by Rouse (J. Chem. Phys., 54: 4135(1971)) in calculating the energy of the hydrogen atom by use of hybrid Gaussian-type orbitals is discussed. It is suggested that apparent errors in the programs used for energy evaluation lead to invalid results, which shed no light on the question of the usefulness of hybrid Gaussian-type orbitals in molecular calculations. (A.G.W.)

13194 GENERAL FORMULAS FOR THE EVALUATION OF THE VALENCE-ORBITAL IONIZATION POTENTIALS FOR THE $K(2)L(8)3s^2 3p^6 3d^\alpha 4s^\beta 4p^\gamma$ OR THE $1s^2 2s^m 2p^n$ ATOMS AND IONS. Anno, Tosinobu; Sakai, Yoshiko (Kyushu Univ., Fukuoka). J. Chem. Phys.; 56: No. 2, 922-5(15 Jan 1972).

Formulas, with which the 3d, 4s, or the 4p VOIP of any atom in any configuration of the type $K(2)L(8)3s^2 3p^6 3d^\alpha 4s^\beta 4p^\gamma$ (type I) and the 2s or the 2p VOIP of any atom in any configuration of the type $1s^2 2s^m 2p^n$ (type II) may be calculated, are obtained. The procedure adopted is a least-squares fitting of all the available data of empirical VOIP's of atoms and ions with these configurations to quadratic functions of α, β, γ, and the atomic number (for the type-I atoms) or of m, n, and the atomic number (for the type-II atoms), which were derived on both the empirical and the theoretical basis in previous works by the present authors. The resulting formulas should be useful in predicting VOIP's of those atoms and ions for which direct evaluation is impossible for lack of experimental data. The formulas should thus facilitate the parametrization of the semiempirical molecular orbital theory, both of the extended Hückel and of the Pariser-Parr type. (auth)

13195 GREEN'S FUNCTIONS IN MANY-ELECTRON, SECOND-ORDER CALCULATIONS. Laurenzi, Bernard J. (State Univ. of New York, Albany). J. Chem. Phys.; 56: No. 1, 619-26(1 Jan 1972).

The calculation of second-order physical properties for many-electron systems of interacting particles is presented in terms of two-particle Green's functions and graphs. These Green's functions are known in the atomic case, and therefore practical computations are now possible. (auth)

13196 CLASSICAL-LIMIT GREEN'S FUNCTION (FIXED-ENERGY PROPAGATOR) AND CLASSICAL QUANTIZATION OF NONSEPARABLE SYSTEMS. Miller, William H. (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 1, 38-45(1 Jan 1972).

On the basis of a classical-limit approximation for the Green's function, a classical quantum condition for general, nonseparable dynamical systems is obtained. Bound-state eigenvalues are seen to be associated with stable periodic trajectories, and quasi-bound (or metastable) states are related to unstable periodic trajectories. Application is made to ns^2 states of the two-electron atom, and quite reasonable results are obtained for the energies of the $1s^2$ and $2s^2$ states of He and H^-. An accurate value is also obtained for the lowest eigenvalue of three identical bosons (e.g., helium atoms) interacting through pair Morse potentials. (auth)

13197 ATOMIC PHYSICS 2. Proceedings of the Second International Conference, July 21-24, 1970, Oxford, England. Sandars, P. G. H. (ed.). London; Plenum Press (1971). 386p. £9.00. (CONF-700724).

Twenty-four papers were presented at this conference, and abstracts for nineteen are included. The topics covered include quantum electrodynamics, the many-body theory of atoms, scattering theory and experiment, beam-foil spectroscopy, modern spectroscopic techniques, the application of atomic-beam resonance to low temperature physics, etc. (UK)

For abstracts of individual papers see: 13132, 13147, 13172-13177, 13198-13203, 13326, 13743, 13790, 13791, and 14220.

13198 RESOLUTION OF THE DENSITY OPERATOR INTO IRREDUCIBLE TENSOR COMPONENTS AND APPLICATIONS TO EXPERIMENT. Omont, A. (Faculte des Sciences, Paris). pp 191-200 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

The properties of angular momentum of fundamental importance in the analysis of the interaction of atoms with electromagnetic radiation are discussed. In particular, as a consequence of the conservation rules for angular momentum the polarization and angular distribution of the radiation emitted or absorbed by the atoms of a vapour are closely related to the distribution of the atoms between the different sublevels. A detailed analysis of the angular momentum properties of atoms and radiation requires all the techniques of angular momentum algebra and the best representation for the density matrix of the internal state of the atoms. The mathematical formalism has already been developed for the interpretation of the angular correlations of radiation

emitted by nuclei, and the object in this paper is to give a brief review of different applications of this formalism in atomic physics, with emphasis mainly on optical pumping experiments and relaxation studies. The different terms of the master equation giving the evolution of the density matrix are first analyzed, and it is then shown how the use of a rotationally irreducible representation simplifies the expression of these terms when they exhibit rotational invariances. The principle of application to the problems of spontaneous emission, absorption and dispersion of resonance light by a vapour, Hanle effect and double resonance, multiple diffusion of resonance radiation and relaxation by collisions, etc., is then considered. 30 references. (UK)

13199 THEORY OF COMPLEX SPECTRA. Feneuille, S. (Laboratoire Aime Cotton, Orsay, France). pp 201-13 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

A general account of current methods of research in this field is given, with emphasis on studies carried out at the above laboratory. Developments in the field of atomic correlations are mentioned, but all of these have a field of application that seems to be limited to very light elements and to the lowest levels of these atoms and is completely nil for complex spectra. Theoretical advances have been made using the more conventional central field approach, and most current studies of complex spectra are carried out using this theory; problems encountered are discussed. In this theory the electrons are considered to move independently in a central electrostatic field and the residual interactions to be small enough to be studied by means of perturbation theory, generally using the Rayleigh–Schroedinger approach. The energy of the atom is thus divided into two parts—a central field energy and a perturbation energy; angular and radial electron coordinates can be separated. Most of the angular coordinate calculations use the Racah methods, with described extensions, and for the radial coordinates mainly empirical methods are employed. Development of the effective operator formalism, which enables taking into account far-configuration-interactive effects to second order, is described. New approaches to the problem of radial wave functions in complex spectra are indicated, especially those based on group theory. 59 references. (UK)

13200 ATOMIC STRUCTURE OF SUPERHEAVY ELEMENTS. Cowan, R. D.; Mann, J. B. (Los Alamos Scientific Lab., N. Mex.). pp 215-26 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

The theory of nuclear stability indicates the likelihood of an island of stable nuclei in the vicinity of Z = 114, whose existence is associated with computed magic numbers at Z = 114 and N = 184, providing strong barriers against both spontaneous fission and alpha-particle decay (at least for nuclei in the lower left-hand part of the "island"). The center of the island also lies on a direct extension of the peninsula of known isotopes, indicating probable stability against β decay. Additional stable islands have been suggested in the vicinity of Z = 126 and 164, but are much less likely possibilities, although it was considered of interest to discuss the probable electronic structures of atoms having atomic numbers in these ranges. Among matters discussed are: the systematics of the periodic system; self-consistent-field calculations and detailed level structures. 14 references. (UK)

13201 MANY-BODY PERTURBATION THEORY APPLIED TO ATOMS. Kelly, Hugh P. (Univ. of Virginia, Charlottesville). pp 227-47 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

The use of many-body perturbation theory in atomic physics is discussed. Applications to the calculation of many different properties are given, such as correlation energies, polarizabilities, hyperfine constants, scattering phase shifts, and Auger rates. In addition, methods for applying many-body theory to molecules are given. 79 references. (auth)

13202 MANY-ELECTRON CORRELATIONS IN ATOMIC ELECTRON SHELLS AND POSSIBLE WAYS OF THEIR EXPERIMENTAL DETECTION. Amusia, M. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). pp 249-69 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

It is stated that the evolution of the theory of many-electron atoms is critically dependent on the development of various approximate methods of solution of the corresponding many-particle Schroedinger equation, and over a long period of time the Hartree–Fock approximation, taking into account solely that part of electron–electron interaction that amounts to the smooth self-consistent field, has been the only approximation proceeding from first principles. The interaction known as residual or direct interaction is neglected in this model, and further refinement and development of the theory calls for taking this into account, but the question arises as to how important are its effects. Even crude estimates show that in a number of processes the role of direct interaction is large and that it must result in considerable coherent effects. Calculations, however, tend to be very cumbersome. The part played by direct interaction, and many-electron effects due to it, is great in all inelastic processes involving atomic electrons with energy transfers up to a hundred or so eV in light atoms and keV in heavy atoms. In experimental work it is necessary to resort to data that could be sufficiently sensitive to the approximations assumed for use in testing them, and it is desirable to choose data suitable for comparison with calculations in single-particle approximation without ambiguity in interpretation. The next step should include formulation of an approximate method of taking correlations into account. Among matters discussed are: theory of photoeffect of noble gas atoms; inelastic electron scattering on noble gas atoms; and double electron processes. 16 references. (UK)

13203 CLASSICAL APPROACH TO ATOMIC THEORY: CORRESPONDENCE PRINCIPLE FOR STRONGLY COUPLED STATES. Percival, I. C. (Univ. of Stirling, Scotland). pp 345-70 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

It is stated that the modern classical approach to atomic physics includes a variety of theories that were stimulated by advances in computation and by a realization of the practical and conceptional weaknesses of the usual approximate quantal theories for many important systems and processes. This approach has provided remarkably accurate estimates of atomic cross sections. Each theory starts with a classical model of charged particles or atoms that interact through Newtonian forces, but the model is used differently in different types of theory. Pure classical mechanics may be used without modification; or classical mechanics is modified in order to understand quantal effects and calculate their magnitudes; or classical methods may be combined with the more usual methods of quantum mechanics. Amongst matters discussed are: the correspondence principle; correspondence identities; one-path considerations; many paths and interference patterns; infinity of paths–bound states; path integrals; complex paths–barriers and inaccessibility; and semiclassical theories. 40 references. (UK)

13204 FORM OF TRUNCATED MULTIPOLAR EXPANSION PAIR FUNCTIONS. Jankowski, K.; Malli, G.; Maysilles, J. H. (Simon Fraser Univ., Burnaby, B. C.). Can. J. Phys.; 49: 2518-20(1 Oct 1971).

The influence of the form of the radial part of the correlation factor on the properties of the truncated multipolar expansion pair functions was investigated for the helium-atom ground state. A Z-dependence analysis of the energy improvements obtained with different lengths of the multipolar expansion is also presented. (auth) (Canada)

Cosmic Radiation

Refer also to abstracts 12127, 12161, 13027, 13100, 13487, 13603, and 13677.

13205 (NP-19149) METHOD TO DETERMINE THE ISOTOPIC COMPOSITION OF COSMIC RAY CARBON. Joensson, G.; Kristiansson, K.; Malmqvist, L. (Lund Univ. (Sweden). Dept. of Physics). Mar 1970. 29p. (KS-7005). Dep. NTIS (U. S. Sales Only).

A method to determine the isotopic composition of cosmic-ray carbon with nuclear emulsions is described. The emulsions were exposed to the primary radiation in a high-altitude balloon flight. The mass determinations were based on measurements of the relation between track width and residual range in the range interval 1 < R < 12 mm. The track width was measured with a

nuclear track photometer. The standard deviation of the experimentally determined mass values of ^{12}C nuclei amounted to 2.9%. (KK) (Sweden)

13206 ENERGY SPECTRUM OF PRIMARY COSMIC-RAY ELECTRONS FROM 20 MeV TO 20 GeV IN 1968 AND 1969. Hovestadt, D.; Meyer, Peter; Schmidt, P. J. (Univ. of Chicago). Astrophys. Lett.; 9: No. 4, 165-8(Nov-Dec 1971).

The energy spectrum of primary cosmic-ray electrons between 20 MeV and 20 GeV was measured with a balloon-borne instrument in 1968 and 1969 from Ft. Churchill, Manitoba. The instrument consisted of an absorption spectrometer, designed to discriminate effectively against nuclear cosmic-ray components and to achieve high-energy resolution. The measured electron spectrum is presented and compared with results by other investigators. (auth)

13207 ANISOTROPY OF HIGH-ENERGY COSMIC-RAY ELECTRONS IN THE DISCRETE SOURCE MODEL. Shen, C. S. (Purdue Univ., Lafayette, Ind.); Mao, C. Y. Astrophys. Lett.; 9: No. 4, 169-74(Nov-Dec 1971).

Because of the rapid loss of energy due to radiation, high-energy cosmic-ray electrons observed at Earth probably all come from a few young and nearby sources. Diffusion of electron flux from these nearby sources gives rise to an anisotropy which becomes unidirectional at high energy. A survey of possible cosmic-ray sources indicates anisotropy of the order of 10% for cosmic-ray electrons in the energy range above 100 GeV. Implications of the detection of this large anisotropy in astrophysics are discussed. (auth)

13208 COSMIC-RAY ISOTROPY AND THE ORIGIN PROBLEM. Speller, R.; Thambyahpillai, T.; Elliot, H. (Imperial Coll. of Science and Tech., London). Nature (London); 235: No. 5332, 25-9(7 Jan 1972).

A detailed study of the trajectories of cosmic rays of magnetic rigidity $\geq 10^{11}$ V in the interplanetary magnetic field showed that the small but statistically significant sidereal variation in the cosmic-ray muon intensity, at a depth of 60 MW(e) in London, can be interpreted in terms of the known motion of the solar system relative to the local galactic rotation frame. When the effect of this solar motion is removed, there is no statistically significant residual variation over the sidereal day. This is compatible with a galactic origin for the particles, provided they can be assumed to propagate through the Galaxy by compound diffusion (see Lingenfelter and others, Astrophys. Lett., 8: 93(1971)). It is also compatible with any galactic-origin model that requires a cosmic-ray streaming velocity ≤ 30 km/sec or with a universal distribution of the particles where the metagalactic energy density is not greatly different from that at the Earth. (UK)

13209 SOME SPURIOUS PHYSICAL EFFECTS IN PENETRATING SHOWERS OF COSMIC RAYS. Razdol'skaya, L. A.; Roinishvili, N. N. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 64: No. 2, 301-4(Nov 1971). (In Russian).

The feasibility of imitating spurious physical effects resulting from errors of measurement technique is studied. It is shown that errors in momentum measurements can lead to a series of spurious effects, i.e., to correlations between interaction parameters and substantial distortions in momentum spectra. (auth)

13210 MEASUREMENT OF DIURNAL COSMIC-RAY INTENSITY VARIATION AT CALCUTTA WITH A MESON TELESCOPE. Alexander, Saramma; Chatterjee, S. D. (Jadavpur Univ., Calcutta). Indian J. Phys.; 44: No. 6, 350-5(Jun 1970).

The diurnal and semidiurnal variations of meson intensity were measured at Calcutta (Geographical latitude 22°32′N and longitude 88°20′E at sea level) with a meson telescope. The diurnal variation has an amplitude of 0.13%, with the time maximum at 10.52 h I.S.T., which corresponds to 11 h 13 min local time. Similarly, the semidiurnal variation was found to have an amplitude of 0.05%, corresponding to a time maximum of 16 h 10 min local time. The results were compared with those obtained at various other stations. (auth)

13211 QUIET-TIME SPECTRA OF COSMIC-RAY ELECTRONS OF ENERGIES BETWEEN 10 AND 200 MeV OBSERVED ON OGO-5. L'Heureux, Jacques (Univ. of Arizona, Tucson); Fan, C. Y.; Meyer, Peter. Astrophys. J.; 171: No. 2, 363-76(15 Jan 1972).

Spectra of cosmic-ray electrons of energies between 10 and 200 MeV were measured over a 1-year period starting March 1968. The measurement was made with a detector system on board the OGO-5 satellite. The instrument consists of a solid-state dE/dx detector, a total-energy CsI detector, a gas Cherenkov threshold detector, and two scintillation guard counters. Time periods during which no solar-flare events were recorded were selected for the study. It was found that during these quiet periods there were numerous intensity variations of the electron flux. These variations, which are seen only below 25 MeV, do not show marked correlation with any solar or interplanetary-medium parameters. The flux of the electrons of energies above 25 MeV, on the other hand, showed a gradual decrease over the 1-year period, paralleling the neutron monitor intensity. The parameter describing this long-term modulation is almost independent of the rigidity of the electrons in the reported energy range. The physical implication of the finding is discussed. (auth)

13212 NORTH-SOUTH ANISOTROPIES IN THE COSMIC RADIATION. Pomerantz, M. A.; Duggal, S. P. (Franklin Inst. Swarthmore, Pa.). J. Geophys. Res.; 77: No. 1, 263-5(1 Jan 1972).

Cosmic-ray intensity data have revealed complex three-dimensional flow patterns in the inner solar system. Significant off-ecliptic anisotropy is a common occurrence. Most cosmic-ray storms during the maximum and minimum epochs of the current solar cycle were characterized by north–south asymmetry. It is almost self-evident that a varying intensity gradient perpendicular to the ecliptic plane is an essential feature of all cosmic-ray modulation mechanisms. Individual events representing various parameters of the north–south intensity observations were studied. (J.C.W.)

13213 SOME RESULTS OF COSMIC-NOISE ABSORPTION IN NORIL'SKA REGION. Zhukova, T. P. pp 192-6 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

The auroral absorption was investigated from data of cosmic noise at 32 and 40 MHz from March 1964 to Feb. 1965. The auroral absorption seasonal variation agrees with the seasonal frequency of appearance of aurorae and has a maximum at equinox and minimum at winter. The diurnal variation is maximum in daytime for summer and at night for winter. The height of the layer causing the absorption is about 70 km. The exponent for dependence from sounding frequency is 1.5 to 1.7. The results are in accordance with that of other authors. (tr-auth)

Direct Energy Conversion

Refer also to abstracts 13227, 13350, 13355, and 14457.

13214 (EUR-4711) IRRADIATION OF AN EMITTER ELEMENT FOR A THERMIONIC CONVERTER EXPERIMENT DICOM-01. Hausner, H.; Klersy, R.; Schuerenkaemper, A.; Simoni, O. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 12 Jul 1971. 26p. Dep. NTIS (U. S. Sales Only). EUR F.Fr. 4.45.

The irradiation of a vented emitter element for a thermionic converter is described. This emitter type could be used in a thermionic fuel element, in which the converters are connected in parallel. The irradiation device is discussed, and the irradiation conditions together with the results of the post-irradiation examination are presented. (auth)

13215 PLANE-WAVE MAGNETO-ACOUSTIC STABILITY OF AN MHD INDUCTION MACHINE. Lessmann, Richard C. (Univ. of Rhode Island, Kingston). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 12, 2428-31(Dec 1971).

A theoretical investigation of stability with respect to one-dimensional magneto-acoustic waves excited from synchronous flow in a narrow-flow-gap MHD induction machine is presented. The fluid is assumed to be a compressible continuum characterized by a constant, scalar, electric conductivity. The effects of viscosity and heat conduction are neglected. A mathematically rigorous stability criterion is developed for large magnetic Reynolds number in terms of bounds on an infinite determinant. More useful is an approximate parameter space stability plot valid for small Alfven Mach number M (= ratio of Alfven speed to sound speed). This plot of disturbance frequency vs M shows that, although there is no significant region of absolute stability, maximum stability for all frequencies occurs for M small. Marginal stability exists if the wavelength of the applied magnetic field is some integer multiple of the excited wavelength, and the device is most sensitive to low-frequency disturbances. (auth)

13216 CASCADE-CONNECTED-ELECTRODE SCHEME FOR MHD APPLICATIONS. Lengyel, L. L. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 12, 2471-3(Dec 1971).

Current distribution measurements were made in the cascade-

connected electrode scheme. The performance characteristics of the electrodes are shown as functions of the potential drop on the cascade resistors. (M.O.W.)

13217 SELF-REGENERATING MOLTEN-SEED ELECTRODES FOR MAGNETOHYDRODYNAMIC POWER GENERATORS. Warszawski, B. (Alsthom Research and Development Lab., Massy, France). Energy Convers.; 12: No. 1, 25-9(Mar 1972).

The projected electrode system described was designed with the aim of tackling anew the problem of the useful life of MHD channels. In this system the conductor proper is the seed itself in the molten state, conveyed, spread, and maintained over the entire channel area corresponding to each electrode by insulating porous bodies whose inner surfaces are flush with the channel wall. The erosion, ablation, and evaporation phenomena and the destructive processes bound up with the flow of the current are exerted upon a liquid conductor whose continuous renewal in the porous bodies endows the electrodes with a virtually unlimited useful life, and introduces into the channel gases only normal constituents. Moreover, the evaporation of the molten seed causes an intense enrichment of the gaseous boundary layers in contact with the electrodes (giving an average concentration of the order of 17%) and an analysis of the electrochemical processes at the molten salt/gas interfaces shows that this vaporized seed is even partly in the form of metallic potassium in the cathodic boundary layer: a notable reduction in the ohmic drop inside the channel and elimination of the arc at the cathode can be expected from this. Nevertheless, this evaporation of seed by the electrodes represents under 1% of the total weight of the gases, that is to say less than the seed normally injected into the combustion chamber and consequently does not substantially modify either the average composition of the gases or the seed cycle. (auth)

13218 ESTIMATE OF ELECTRIC FIELD IN THE CHANNEL OF MHD GENERATOR BY THE APPROXIMATION METHOD OF TRANSFORMATION. Poberezhskii, L. P.; Yakhot, A. O. Magn. Gidrodin.; No. 4, 89-94(Oct-Dec 1970). (In Russian).

An approximation calculation method is given for two-dimensional and three-dimensional electric fields in an MHD-generator channel with cylindrical or spherical electrodes. A method of selection of a simple system of charges is pointed out, which provides the approximate fulfillment of the boundary conditions. An experimental method for determination of the electric conductivity of a plasma in an MHD generator is given. The results of calculations and modeling on electric conducting paper are given in diagrams. (tr-auth)

13219 SELECTION OF OPTIMUM CONDITIONS AT CHANNEL ENTRANCES OF MHD GENERATORS. Donskoi, K. V.; Dunaev, Yu. A.; Nazarov, E. V.; Shakhnov, I. I. Magn. Gidrodin.; No. 4, 101-5(Oct-Dec 1970). (In Russian).

Optimum parameters at the channel entrance of an MHD generator are analyzed for combustion products of variable composition that satisfy the condition of thermodynamic equilibrium. The cases of a uniformly partitioned channel and a channel with solid electrodes are examined. It is shown that the optimum conditions at the entrance of these two types of channels are intrinsically different. The analysis is conducted for a wide range of pressures in the combustion chamber. (tr-auth)

13220 CONTROL OF DISTRIBUTION OF ELECTRODYNAMIC FORCES IN CONDUCTING SUBSTANCES ALONG DIRECTION OF MOTION OF TRAVELING MAGNETIC FIELD. Krumin, Yu. K. Magn. Gidrodin.; No. 4, 109-14(Oct-Dec 1970). (In Russian).

The distribution of electrodynamic forces in a conducting substance, in two traveling magnetic fields with different frequencies and pole spacings, was examined along the direction of field propagation. It was found that zones emerge along the substance, where forces act, which can be transposed along the substance in relation to characteristics of the fields. (tr-auth)

13221 OPTIMUM-SERIES MHD GENERATOR. Pleshanov, A. S.; Lazarev, P. P. Magn. Gidrodin.; No. 4, 81-8(Oct-Dec 1970). (In Russian).

Variational equations are obtained and numerically integrated in the optimization of a series MHD generator with a given load, with calculation of the relation of conductivity and Hall parameter from temperature and pressures. It is shown that the optimum boundary condition can exist even when the external part of the function is not equal to zero. An optimum-series MHDG has greater thermodynamic efficiency for gases, with greater values of ratio of heat capacities. The maximum thermodynamic efficiency of this generator is lower than in an optimum equal-volume supersonic Faraday MHDG with constant channel cross-sectional area, and higher if the latter operates in the subsonic regime. The effect of variable conductivity on optimum characteristics of Faraday-type MHDG with constant-channel cross-sectional area. The calculation of variable conductivity can lead to a nonmonotonic change of the load parameter K, along the channel with constant cross-sectional area, so that with $K_1 = \frac{1}{2}$ there proves to be a possible condition $K_2 = \frac{1}{2}$ that also realizes the outer extremum of power. (tr-auth)

13222 METHOD FOR THE MAGNETOHYDRODYNAMIC CONVERSION OF MECHANICAL ENERGY OF A FLOWING ELECTRICALLY CONDUCTIVE FLUID INTO MAGNETIC ENERGY. Steenbeck, Max; Krause, Fritz (to Deutsche Akademie der Wissenschaften Zu Berlin). British Patent 1,257,077. 15 Dec 1971. Filed 4 Feb 1969.

A method is described for the production of spatially extended intense stationary magnetic fields, utilizing the α-effect, the apparatus employed is called a hydromagnet, and is of relatively low weight. Limitations of methods hitherto employed are outlined. An electrically conducting fluid is given a nonmirror-symmetrical flow and caused to flow in a magnetic excitation field. The emf produced parallel to the excitation field leads to the production of a heavy closed circuit current that creates a magnetic main field. The electrically conducting fluid forms a conductor for this current, and also conducts away the heat produced, with the assistance of cooling means. The magnetic excitation field may be produced in one of several auxiliary flow groups by the α-effect, as a result of self-excitation, and a weak external field may be applied to establish the polarity of the magnetic field at the commencement of self-excitation. (UK)

Fluid Physics

13223 CONVECTION IN A VISCOELASTIC FLUID LAYER IN HYDROMAGNETICS. Bhatia, P. K. (Univ. of Jodhpur, India); Steiner, J. M. Phys. Lett.; 37A: No. 5, 419-20(20 Dec 1971).

The effect of a magnetic field on the overstable mode of convection in a visco-elastic fluid layer is considered for the cases of two free two rigid boundaries. It is found that the effect of the magnetic field is stabilizing. (auth)

13224 ON SOME EXACT SOLUTIONS IN MAGNETOHYDRODYNAMICS WITH ASTROPHYSICAL APPLICATIONS. Sozou, C. (Univ. of Sheffield, Eng.). J. Fluid Mech.; 51: 33-8(11 Jan 1972).

Some exact solutions of the steady magnetohydrodynamic equations for a perfectly conducting inviscid self-gravitating incompressible fluid are discussed. It is shown that there exist solutions for which the free surface of the liquid is that of a planetary ellipsoid and rotates with constant angular velocity about its axis. (auth)

13225 INTRINSIC EQUATIONS OF MAGNETOGASDYNAMICS: NONSTATIONARY CASE. Ferrero, G. M. (Univ., Turin). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 105: No. 4, 659-71(Jul-Aug 1971). (In Italian).

The triple orthogonal system of magnetic lines of force and principal normal and binormal lines are considered, after the usual assumptions for nonsteady magnetogas flow. Intrinsic equations of magnetogasdynamics and behavior of Alfvén's velocity are determined. (auth)

13226 DEVELOPMENT OF MHD FLOW IN THE ENTRANCE REGION OF A CHANNEL. Wu, S. T.; Fu, T. S.; Wear, M. B. (Univ. of Alabama, Huntsville). Rev. Phys. Appl.; 6: No. 3, 409-14(Sep 1971).

A general method was developed for determining the developing MHD flow in the entrance region of a parallel-plate channel. Closed-form solutions are obtained. Numerical results are presented for the development of velocity distribution, pressure drop, and magnetohydrodynamic entrance length at different Hartmann numbers. At large Hartmann numbers, the magnetic field effect becomes dominant and the MHD entrance length becomes negligible. Also, the pressure drop is enhanced by the magnetic field. Comparison of the results with direct numerical analysis shows excellent agreement. (auth)

13227 HYDROMAGNETIC FLOW OVER CONDUCTING AND NONCONDUCTING WALLS. Ray, M. (Agra Coll., India); Agrawal, J. C. Indian J. Pure Appl. Math.; 2: No. 3, 374-86 (Jul 1971).

Flow past a porous plane wall under a transverse magnetic field is considered. In the case when the wall is electrically nonconducting, reducing the applied magnetic field to zero makes the flow

field the same as in the ordinary hydrodynamical case; however, it is shown here that for a perfectly conducting wall this is not true. This result is particularly interesting when applied to liquid-metal MHD power generators where the electrodes are almost perfect conductors. A detailed investigation of the shear stress on the wall, displacement thickness, energy equation, and heat transfer is presented. Due to the conductivity of the wall, heat transfer at the wall is reduced by the amount $\rho v_0 U^2 S/2$ than the corresponding value for a nonconducting wall. (auth)

13228 EFFECTS OF EXTERNAL CIRCUIT ON HEAT TRANSFER IN A CHANNEL FLOW BETWEEN CONDUCTING WALLS. Soundalgekar, V. M. (Indian Inst. of Tech., Bombay); Desai, G. A. Indian J. Pure Appl. Math.; 2: No. 3, 479-86 (Jul 1971).

An analysis of heat transfer in fully developed channel flow between conducting walls is presented. An external circuit is considered and closed-form solutions for temperature, Nusselt number, and mean mixed temperature are derived. Effects of M (the Hartmann number), T_1 (temperature difference of walls), $\phi_1 + \phi_2$ (sum of electrical conductance ratio of two walls) and I (the total current) on the temperature field are discussed. (auth)

13229 THEORETICAL STUDY OF THE INTERACTION BETWEEN TWO ONE-DIMENSIONAL FLOWS OF VISCOUS ELECTRICALLY CONDUCTING LIQUIDS IN A MAGNETIC FIELD. Poirier, Yves (Centre Univ. de la Reunion, Saint Denis, France). Compt. Rend., Ser. A; 273: No. 19, 865-8(8 Nov 1971). (In French).

The two flows take place in very flat rectangular tubes that act as high-conductivity electrodes. These electrodes are connected in twos, enabling the free circulation of induced currents between the two tubes when a magnetic induction is applied. The local velocities and the mean velocities in the two straight sections are calculated as functions of the Hartmann numbers and the longitudinal pressure gradients applied. The numerical results obtained for the various parameters are presented in the form of graphs. (auth) (France)

13230 EFFECTIVE ELECTRICAL CONDUCTIVITY OF TWO-PHASE GAS–LIQUID–METAL FLOWS. Alad'ev, I. T.; Gavrilova, N. D.; Dodonov, L. D. Heat Transfer - Sov. Res.; 3: No. 4, 21-7(Jul-Aug 1971).

Results of measuring the electric conductivity of two-phase sodium vapor flow in a flat channel with a flow temperature of $T \simeq 1050°K$ are presented. Published data are analyzed and compared. It is shown that: for some two-phase flow variables the emf induced by the two phases is higher than that induced by a single phase at the same mass-flow rate; the effective thermal conductivity of two-phase flow is determined by the conductivity of the liquid phase of the flow which is in mutual contact; and the magnetic field affects the two-phase flow structure and, consequently the effective conductivity, of an electrically conducting liquid. (auth)

13231 CALCULATION OF ELECTRIC CHARACTERISTICS OF MHD GENERATORS USING MATRIX OF SELF- AND MUTUAL IMPEDANCES. Poberezhskii, L. P.; Yakhot, A. O. Magn. Gidrodin.; No. 4, 95-100(Oct-Dec 1970). (In Russian).

In terms of theoretical electromechanics, an MHD generator is a linear multipole network, the electrical characteristics of which are determined completely by a matrix of self- and mutual impedances. The method of determination of the matrix coefficients of self- and mutual impedances for the case of an MHD generator with semicylindrical or semispherical electrodes is indicated. Using the proposed method in certain assumptions, the characteristics of electrodes with three arc spots are calculated. The properties of the matrix are examined in presence of the Hall effect. (tr-auth)

13232 ELECTROMAGNETIC PHENOMENA IN CONDUCTING LAYER IN FIELD OF TWO INDUCTORS WITH MUTUALLY OPPOSED TRAVELING MAGNETIC FIELDS. Veze, A. K.; Mikel'son, A. E. Magn. Gidrodin.; No. 4, 115-18(Oct-Dec 1970). (In Russian).

The electromagnetic force acting on an infinite electroconducting layer of thickness 2B in the traveling magnetic field of a bilateral inductor is examined for the case of oppositely moving magnetic fields with arbitrary phase shifts ϕ. It is found that in the conducting layer pulsating forces emerge, the magnitude and direction of which depend on the distance from the point considered to the surface of the layer and are varied both in time, and along the direction of motion of the traveling magnetic field. For comparison, an analogous calculation is cited for the case when the traveling fields move in one direction. (tr-auth)

13233 EQUIVALENT SCHEME OF MHD CHANNEL WITH NONCONDUCTING PARTITIONS OF FINITE LENGTH. Lavrent'ev, I. V. Magn. Gidrodin.; No. 4, 119-24(Oct-Dec 1970). (In Russian).

For an MHD channel with nonconducting partitions of finite length, an equivalent scheme is proposed and, on the basis of it, the integral characteristics of the channel are obtained in relation to the number and lengths of the partitions and the magnetic field distributions along the channel. The scheme is valid only for the case where the partitions start immediately beyond the electrode zone. (tr-auth)

13234 INFLUENCE OF CONDUCTIVITY OF WALLS AND VELOCITY PROFILES ON JOULE LOSSES IN MHD CHANNELS. Vasil'ev, V. F.; Lavrent'ev, I. V. Magn. Gidrodin.; No. 4, 125-31(Oct-Dec 1970). (In Russian).

The solution of the problem of electric field distribution for the flow of a conducting fluid in a transverse magnetic field in a channel of rectangular cross section and infinite length with thin conducting walls of arbitrary conductivity is presented. The opposite walls are assumed to be in equal pairs, the vector of constant magnetic field is directed parallel to one of the walls, the velocity profile is given as a function of two parameters, which characterize the velocity variation along the width and the height of the channel. An expression is obtained for the Joule dissipation in the channel and the relations of Joule losses are given for the parameters that characterize the conductivity of the walls, the velocity profile and relation of sides of the channel, constructed in a wide range of these parameters. The cases are examined in detail when all of the walls are equal and have arbitrary conductivity and when the walls parallel to the magnetic field are perfect conductors and the others have arbitrary conductivity. The last channel is also studied in the regimes, when the total current through it is nonzero. (tr-auth)

13235 ENTRANCE OF SHOCK WAVE WITH CONDUCTIVITY JUMP IN TRANSVERSE MAGNETIC FIELD. But, D. A. Magn. Gidrodin.; No. 4, 3-10(Oct-Dec 1970). (In Russian).

The interaction of a shock wave, which ionizes an ideal gas, with a transverse magnetic field in a coaxial channel was studied experimentally and theoretically. (M.H.R.)

13236 ACCURATE SOLUTION OF ONE-DIMENSIONAL NONSTATIONARY EQUATIONS OF MAGNETOHYDRODYNAMICS WITH FINITE CONDUCTIVITY OF THE GAS. Cherepanov, A. N.; Yakovlev, V. I. Magn. Gidrodin.; No. 4, 11-18(Oct-Dec 1970). (In Russian).

The one-dimensional nonstationary motion of a compressible electroconductive gas in a magnetic field perpendicular to the direction of motion is considered, allowing for thermal conductivity and viscosity. It is assumed that the gas satisfies the equation of state of an ideal gas; the thermal conductivity, viscosity, and electric conductivity depend on pressure and density in the form of power functions. By the method of separation of variables, an accurate solution was found for the MHD equations describing the motion of the media considered, on the premise that the velocity field has the form of a linear nonhomogeneous function of the steric coordinates. The equation obtained describes both the expansion (compression) of the conducting gas and the motion of a plane source or motion under the action of a piston. As an example, the problem of the expansion of a plane layer of heat-conducting inviscid gas with constant conductivity in an external magnetic field was examined. It is supposed that, in the plane of symmetry, there is a source of gas with variable parameters. (tr-auth)

13237 ACCURATE SOLUTION OF BOUNDARY PROBLEMS DESCRIBING END EFFECTS IN MHD CHANNEL WITH SEMI-INFINITE ELECTRODES. Kirshtein, G. Kh.; Kozyrenko, V. E. Magn. Gidrodin.; No. 4, 19-23(Oct-Dec 1970). (In Russian).

An accurate solution is given for composite boundary-value problems describing the longitudinal end effect with arbitrary R_m at the entrance to the interelectrode zone of the MHD channel. Two cases with given applied magnetic field are examined— constant everywhere in the flow and concentrated only in the interelectrode zone. In the limiting case, when one of the channel walls is assumed infinite, the solution of one of the problems is expressed in a simple form in terms of the probability integral. On this basis it is shown that, as in the case of use of the method of successive approximation, with increase of R_m the end effect at the entrance to the interelectrode zone is strengthened. The results are compared with analogous results previously obtained by Fouad and Weiss. (tr-auth)

13238 NONRATED REGIMES OF FLOW OF CONDUCTING FLUID IN CONSTANT MAGNETIC FIELD WITH FIXED DIRECTION OF ELECTRIC FIELD AND ONE LOAD. El'kin, A. I. Magn. Gidrodin.; No. 4, 24-30(Oct-Dec 1970). (In Russian).

Flow of a conducting fluid from the receiver is investigated, where the parameters of an adiabatically delayed gas are fixed, through a nozzle in a channel operating in the generator regime with constant lengthwise magnetic field induction and cross section. Nonrated regimes are studied that originate in the divergence of load current, from calculated values, Hall parameter, electric field directions, with the appearance of compression shocks in channel or Laval nozzle, and nonrated regimes that emerge in the startup process of the system (Laval nozzle, channel, or ultrasonic diffuser). It is shown that supersonic flow and fixed parameters of adiabatically delayed gas critical lengths, corresponding to thermodynamic cutoff on the yield from the channel, can tend to zero, infinity, or a definite range. The flow regimes considered here are always independent of the amount of the electrical load in the whole range of practical interest of parameter variation. The possibility of obtaining greater diffuser efficiency than with the same velocity coefficients at the entry of the supersonic diffuser with nonregulated entrance in ordinary hydrodynamics is shown. (tr-auth)

13239 MAGNETOHYDRODYNAMIC TURBULENCE. Moro, R. Magn. Gidrodin.; No. 4, 31-40(Oct-Dec 1970). (In Russian).

The distribution and transport of energy in the space of wave numbers in MHD turbulent flow are studied. The anisotropic character of the Joule dissipation that plays the main role in the boundaries of a cone with aperture angle approximately 60° with the axis parallel to the magnetic field is stressed. The role of fluctuations of the electric field is shown. Limits are given for certain characteristics quantities, e.g., the relation of Joule to viscous dissipation, the time scale of large vortices. The energy distribution in the limiting cases $^2Ha \gg 1$ and $^2Ha \ll 1$ is investigated. The simple analytical axially symmetric model of isotropic turbulence is examined. The possible mechanisms of diminishing of MHD turbulence and, in particular, the self-similar case are studied. (tr-auth)

13240 MEASUREMENT OF TURBULENT VELOCITY FLUCTUATIONS WITH CONDUCTING ANEMOMETER WITH THREE-ELECTRODE PROBE. Kit, L. G. Magn. Gidrodin.; No. 4, 41-6(Oct-Dec 1970). (In Russian).

The effect of short-circuit currents on the response of conduction anemometers is analyzed. On the basis of experiments with a three-electrode detector, the conditions appear for which conduction anemometers give sufficiently reliable data concerning turbulent velocity fluctuations. These conditions are realized best by damping measurements in magnetic field turbulence. (tr-auth)

13241 INVESTIGATION OF INFLUENCE OF SPATIAL END EFFECTS ON MAGNETOHYDRODYNAMIC FLOW IN CHANNEL WITH NONCONDUCTING WALLS. Kit, L. G.; Peterson, D. E.; Platnieks, I. A.; Tsinober, A. B. Magn. Gidrodin.; No. 4, 47-53 (Oct-Dec 1970). (In Russian).

The effect of magnetic field heterogeneity along the direction of motion on the flow of fluid in a rectangular channel with nonconducting walls was studied experimentally and numerically. It was found that the presence of such a heterogeneity produced characteristic M-shaped velocity profiles. At larger Stewart numbers, these profiles differ essentially from velocity distribution in homogeneous fields. (tr-auth)

13242 MEASUREMENT OF VELOCITY PROFILES AND FLUCTUATIONS IN PLANE CHANNEL LOCATED BY THE LONG SIDE OF CROSS SECTION PARALLEL TO TRANSVERSE MAGNETIC FIELD. Branover, G. G.; Slyusarev, N. M.; Shcherbinin, E. V. Magn. Gidrodin.; No. 4, 54-8(Oct-Dec 1970). (In Russian).

It was established that, in a rectangular pipe oriented relative to the transverse magnetic field so that the Hartmann effect was substantially weakened, the turbulent velocity profiles approach parabolic; yet for the given geometric pipe ratios the closest approach of the profile to parabolic was observed at $Ha/Re \approx 7.5 \times 10^{-3}$. A study of part of the replotting of the flow at its entry into the magnetic field showed that the profile, close to parabolic, is determined by the pipe length, equal to approximately 50 times its half-width. By the measurements of the intensity of the longitudinal and transverse pulsations, it was shown that in a magnetic field the intensity of the transverse fluctuations becomes significantly lower than the longitudinal intensity, and the correlation between them falls back proportionally to the Hartmann number. The magnetic field decreases most strongly the energy of the low- and high-frequency parts of the spectrum of fluctuations. In the quantitative relation the intensity of fluctuations and their spectra in weak magnetic fields are in good agreement with data of hot-wire anemometer measurements of other authors. (tr-auth)

13243 EXPERIMENTAL STUDY OF MHD FLOW IN DIFFUSER AND NOZZLE. Slyusarev, N. M.; Shilova, E. I.; Shcherbinin, E. V. Magn. Gidrodin.; No. 4, 59-64(Oct-Dec 1970). (In Russian).

The velocity and potential distributions in mercury in a rectilinear diffuser and nozzle with aperture angle 4°30′ in a transverse magnetic field were studied. It was found that in a magnetic field such flows have an essentially spatial hydrodynamic and electrodynamic structure. (tr-auth)

13244 STEADY FLOW OF CONDUCTING FLUID IN TRAVELING FIELD. Tkachenko, V. F. Magn. Gidrodin.; No. 4, 65-70 (Oct-Dec 1970). (In Russian).

The laminar flow of a viscous electroconducting fluid in a traveling magnetic field is examined. Under conditions when it is possible to neglect the effect of fluid motion on the electromagnetic processes or to consider this effect according to the average flow velocity, expressions are obtained for pressure and velocities in the fluid. The flow is considered in a field of uni- and bilateral inductors (matched and opposed connections). A given tangential component of magnetic field strength on the wall is assumed. Velocity profile diagrams are given. (tr-auth)

Upper Atmosphere Physics

Refer also to abstracts 13079 and 13213.

13245 (TID-25846) LIGHTNING INDUCED BY THERMONUCLEAR DETONATIONS. Uman, M. A. (Westinghouse Research Labs., Pittsburgh, Pa.); Seacord, D. F. (EG and G, Inc., Bedford, Mass.); Price, G. H.; Pierce, E. T. (Stanford Research Inst., Menlo Park, Calif.); Holzer, R. E. (California Univ., Los Angeles). [1971]. 19p. Dep. NTIS.

The lightning flashes induced by a thermonuclear detonation at Eniwetok Atoll in the Pacific in 1952 are described. The five discharges were upward-propagating and were apparently initiated from instrumentation stations slightly above sea level. The likely mechanism for the necessary charge and electric field generation, Compton electrons produced by gamma rays from the detonation, is explored quantitatively. The electric field intensity calculated, 3×10^4 V/m, is near the value needed to initiate lightning from surface projections. The charge estimated to be available, however, appears to be insufficient to account for the observed lightning. Scattered trade-wind cumulus clouds and spray electrification from the salt water are considered and rejected as charge sources. (auth)

13246 AURORAL-ZONE ELECTRON PRECIPITATION EVENTS OBSERVED BEFORE AND AT THE ONSET OF NEGATIVE MAGNETIC BAYS. Pytte, T.; Trefall, H. (Univ. of Bergen, Norway). J. Atmos. Terrest. Phys.; 34: No. 2, 315-37(Feb 1972).

Balloon recordings of bremsstrahlung x rays from precipitating electrons are presented, showing impulsive x-ray events just at the onset of bay activity, as well as weaker and smoother electron precipitation before the bay, the latter apparently being connected with a growth phase of the same substorm. The pre-bay events are generally very smoothly varying events, but show modulation effects associated with the occurrence of irregular magnetic pulsations. The impulsive precipitation events start very abruptly together with Pi 2 magnetic pulsations at bay onset, and also show modulation effects, so that maxima in the x-ray flux tend to accompany maxima in the H component at auroral-zone stations. These x-ray pulsations have a shorter period than the simultaneous midlatitude Pi 2, which possibly indicates that the impulsive precipitation events occur on field lines close to the inner edge of the neutral sheet. (auth)

13247 ELECTRON CONTENT AND OTHER RELATED MEASUREMENTS FOR A LOW-LATITUDE STATION OBTAINED AT SUNSPOT MAXIMUM USING A GEOSTATIONARY SATELLITE. Walker, G. O.; Ting, S. D. (Univ. of Hong Kong). J. Atmos. Terrest. Phys.; 34: No. 2, 283-94(Feb 1972).

Electron-content measurements were made at Hong Kong (lat. 22.2°N, dip 30°) for the period July 1967 to December 1968 by continuously recording the polarization angle of a signal from the

geostationary satellite Syncom 3. Monthly median peak diurnal contents exhibited a semiannual variation with maxima occurring at the equinoxes and a winter anomaly effect was noted during the daytime. However, this latter effect was not apparent for midnight values, though the semiannual variation remained. The rate of increase in content with solar flux since 1964–5 was greatest for the winter, and during this season, the measured scale heights were also greatest, thus possibly implying a seasonal increase in the composition ratios $[O]/[O_2]$ and/or $[O]/[N_2]$. Good short-term correlation between the daily peak electron content and the daily solar flux was established. The equivalent thickness exhibited a broad daytime increase during the summer, but at other seasons sharp peaks occurred after sunset and before sunrise. (UK)

13248 IONOSPHERIC EFFECTS OF SOLAR FLARES. V. THE FLARE EVENT OF 30 JANUARY 1968 AND ITS IMPLICATIONS. Deshpande, S. D.; Ganguly, S.; Jain, V. C.; Mitra, A. P. (National Physical Lab., Delhi). J. Atmos. Terrest. Phys.; 34: No. 2, 267-81(Feb 1972).

From riometer and pulse absorption measurements on three frequencies for the large x-ray flare event that occurred on January 30, 1968, electron-density profiles are derived for the entire course of the flare. The time variation of the electron production rate is obtained for this event from satellite measurements of x rays in the bands 0 to 3 Å, 0 to 8 Å and 8 to 20 Å. A comparison of these profiles with the electron production rates deduced from the x rays reveals a decrease in the effective recombination coefficient or of the negative ion to electron ratio λ, in agreement with the results reported by Rowe et al. (1970). (auth)

13249 IONOSPHERIC EFFECTS OF SOLAR FLARES. IV. ELECTRON DENSITY PROFILES DEDUCED FROM MEASUREMENTS OF SCNA'S AND VLF PHASE AND AMPLITUDE. Deshpande, S. D.; Mitra, A. P. (National Physical Lab., Delhi). J. Atmos. Terrest. Phys.; 34: No. 2, 255-66(Feb 1972).

A method is presented by which electron-density profiles in the D region of the ionosphere may be derived during solar flares from SCNA measurements at two frequencies and simultaneous measurements of SCNA's and SPA's at vlf. A parabolic profile is assumed. At lower levels, the profile is estimated from the measurements of phase and amplitude changes at vlf. Profiles are obtained for a number of flare events, and are compared with those derived recently by cross-modulation, partial reflection, and rocket techniques. It is observed that the enhanced electron density at 60 km is of the order of 100 cm^{-3} during an average flare effect, about 900 cm^{-3} around 70 km, but increases steeply with height to about 10^4 cm^{-3} around 85 km. (auth)

13250 IONOSPHERIC EFFECTS OF SOLAR FLARES. III. THE QUANTITATIVE RELATIONSHIP OF FLARE X-RAYS TO SID'S. Deshpande, S. D.; Mitra, A. P. (National Physical Lab., Delhi). J. Atmos. Terrest. Phys.; 34: No. 2, 243-53(Feb 1972).

The effects of changes in the spectral distribution of solar x rays below 10 Å, on the nature and magnitude of sudden cosmic noise absorption (SCNA) are described and 50 SCNA's are compared with x-ray flares for which spectral distributions could be deduced. It is observed that the SCNA increases by an order of magnitude when the equivalent spectral temperature increases from 2×10^6 °K to 8×10^7 °K even though the total x-ray flux below 10 Å is kept constant. It is further observed, from an examination of the threshold case, and from quantitative study of 50 flare events, that the required recombination coefficients in the region 70 to 90 km are considerably lower than those recently given by Reid (1970), and that these generally fall into one of three categories: one very low, similar to that of Mitra (1968); another relatively high (but lower than that of Reid) with values around 2×10^{-5} cm^3 sec^{-1} at 70 km and 4×10^{-6} cm^3 sec^{-1} at 80 km, and the third, intermediately between the two and approximating to the models of Adams and Masley (1965) and Mitra and Banerjee (1970). It is suggested that Reid's recombination coefficient model, which is not consistent with any of the flare models, represents the quiet time situation and that during the flare there is a decrease in the coefficient. (auth)

13251 IONOSPHERIC EFFECTS OF SOLAR FLARES. II. THE FLARE SPECTRUM BELOW 10 A DEDUCED FROM SATELLITE OBSERVATIONS. Deshpande, S. D.; Mitra, A. P. (National Physical Lab., Delhi). J. Atmos. Terrest. Phys.; 34: No. 2, 229-42(Feb 1972).

The spectral distribution and its time development for x rays below 10 Å during solar flares are deduced from the measurements of integrated flux levels by satellite-borne detectors in the 0.5- to 3-Å and 1- to 8-Å bands. An exponential distribution and a power law distribution are considered, as well as a composite spectrum with two different electron-temperatures in the bands 0.5- to 3-Å and 3- to 8-Å. Analysis of x-ray response for selected flare events gave spectral temperatures of about (1 to 3) $\times 10^7$ °K for $\lambda < 3$ Å and about (8 to 10) $\times 10^6$ °K for $\lambda > 3$ Å. The power law representation gave a distribution of λ^m, with m having values between 1 to 2 at the peak of the flare. Gradual changes in spectral temperatures are shown for some events. (auth)

13252 IONOSPHERIC EFFECTS OF SOLAR FLARES. I. THE STATISTICAL RELATIONSHIP BETWEEN X-RAY FLARES AND SID'S. Deshpande, S. D.; Subrahmanyam, C. V.; Mitra, A. P. (National Physical Lab., Delhi). J. Atmos. Terrest. Phys.; 34: No. 2, 211-27(Feb 1972).

The sudden ionospheric disturbances (SID's) produced in the Earth's ionosphere by enhanced solar radiation during solar flares are examined in the light of recent information on flare x-ray omission. The SID's cover the vlf to lf, as well as hf effects. It is found that the occurrence probability of SID's with x-ray flares increases as the emission extends towards the shorter end of the x-ray spectrum. An x-ray enhancement concurrent with both H_α and radio events is generally large and is capable of producing all SID effects, including the sudden frequency deviation (SFD) and a crochet in 80% of the cases. A threshold flux of 1×10^{-3} erg cm^{-2} sec^{-1} ($T = 2 \times 10^6$ °K) in the 0- to 8-Å band and a threshold ratio of 0- to 3-Å to 0- to 8-Å flux level of 1.5×10^{-2} is sufficient to produce a detectable SID effect. The size of an SID effect increases with x-ray enhancements in 0- to 3-Å, 0- to 8-Å, 2- to 12-Å bands, but the relationship is not linear. The relaxation time of most SID effects (excluding SFD) with reference to x-ray flares in 0- to 8-Å, 2- to 12-Å, and 8- to 12-Å bands is 2 to 3 min. The time curves of SID's are similar to those of x rays in 0- to 3-Å, 0- to 8-Å, and 2- to 12-Å bands but there are differences in details. (auth)

13253 IONOSPHERIC MOVEMENTS MEASURED BY INCOHERENT SCATTER: A REVIEW. Evans, J. V. (Massachusetts Inst. of Tech., Lexington). J. Atmos. Terrest. Phys.; 34: No. 2, 175-209(Feb 1972).

Precise measurements of the frequency spectra of signals incoherently scattered by ionospheric electrons often reveal slight shifts caused by macroscopic motions of the ions. Drifts measured by radars in France, Peru, Puerto Rico, and United States were reported and attributed to (i) motions of the neutral atmosphere; (ii) electric fields; (iii) expansion and contraction of the F layer; (iv) gravity waves; and (v) fluxes into or out of the protonsphere. These measurements and the interpretations placed upon them are summarized, and means by which the utility of the incoherent scatter technique could be exploited further are suggested. (UK)

13254 ADDITIONAL ELECTRON FLUX DETECTION AFTER MAGNETIC PERTURBATIONS. Volobu'ev, S. A.; Galper, A. M.; Dmitrenko, V. V.; (and others) (Engineering Physical Inst., Moscow). Solar Phys.; 20: No. 2, 491-6(Nov 1971).

An additional electron flux at an energy above 100 MeV was observed in the experiments carried out with high-altitude balloons flown at geomagnetic latitudes 46 and 49°, in the upper layers of the atmosphere, on the days following magnetic perturbations. Its intensity, equal to 6×10^{-2} cm^{-2} s^{-1} sr^{-1}, decreased over 20 to 30 hours. The effect observed confirms the presence of high-energy electrons in the regions of the trapped radiation. (auth)

13255 ELECTRON-TEMPERATURE-GRADIENT INSTABILITY AND ITS POSSIBLE APPLICATION TO THE IONOSPHERE. Cunnold, D. M. (Massachusetts Inst. of Tech., Lexington). J. Geophys. Rex.; 77: No. 1, 224-33(1 Jan 1972).

Consideration is given to a low-frequency mode of instability that can arise in a partly ionized plasma as a result of an electron temperature gradient aligned perpendicular to a magnetic field. The irregularities so produced are essentially thermal in nature but are associated with related electron-density fluctuations. The unstable mode propagates at approximately the electron drift velocity in a direction essentially perpendicular to the magnetic-field lines. An additional requirement for instability is that there should exist an electron density gradient having a component in the direction of and of the same sign as the electron temperature gradient. It is also necessary that the scale for the electron density variation should be roughly a factor of 7/3 greater than the scale of the electron-temperature variation. Application of this instability to the ionosphere is considered. It is found that the energy loss from the electron gas by virtue of collisions with ionized and neutral particles prevents the occurrence of this instability under most ionospheric conditions. However, if electron temperature variations on the scale of about a kilometer were to exist in the auroral ionosphere, for example, field-aligned ir-

regularities of size 10 to 100 meters could be produced as a result of this instability at altitudes above about 140 km. (auth)

13256 EFFECTS OF INTERPLANETARY MAGNETIC FIELD ON PROPAGATION OF FLARE-GENERATED INTERPLANETARY SHOCK WAVES. Tam, C. K. W; Yousefian, V. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res.; 77: No. 1, 234-8 (1 Jan 1972).

The effects of an interplanetary magnetic field on the propagation of flare-generated interplanetary shock waves are investigated with an approximate analytical method. It is found that the interplanetary magnetic field is relatively unimportant for strong shocks as far as the shock speed and transit time are concerned. It has more significant effects for weak shocks. However, in all the situations examined, the error committed if the magnetic field is neglected is no more than 10%. It is suggested that a model without a magnetic field gives sufficiently accurate numerical results for the propagation of flare-generated shocks. (auth)

13257 MIDDAY AURORAS AND MAGNETOSPHERIC SUBSTORMS. Akasofu, S.-I. (Univ. of Alaska, College). J. Geophys. Res.; 77: No. 1, 244-7(1 Jan 1972).

The equatorward motion of the midday auroras was observed during substorms, and its significance is discussed. (auth)

13258 THERMALIZATION OF COLLIDING ION STREAMS BEYOND THE PLASMAPAUSE. Schulz, Michael; Koons, H. C. (Aerospace Corp., El Segundo, Calif.) J. Geophys. Res.; 77: No. 1, 248-54(1 Jan 1972).

On field lines that are closed, oppositely directed plasma flows analogous to the polar wind have recently been detected in the ionospheric trough regions. Those originating from conjugate regions of the ionosphere will encounter each other near the equatorial plane. For a background plasma of sufficiently low equatorial density ($N_0 \lesssim 20$ cm^{-3}), thermalization of the two streams can occur through the excitation of unstable ion waves. At higher densities ($N_0 \gtrsim 20$ cm^{-3}) thermalization occurs via coulomb collisions. These flows, together with the complementary thermalization mechanisms not previously analyzed, constitute a rapid means of replenishing the plasmasphere ($dN_0/dt \sim 10$/cm^3 hr) during the recovery phase of a magnetic storm. Upward flows have long been suspected of playing such a role. Beyond the quiet-day plasmapause location, the conditions for two-stream instability appear to be present continuously, since the counterstreaming plasmas are simultaneously convected to the magnetospheric boundary. (auth)

13259 SOLAR-ECLIPSE EFFECT ON SPORADIC-E IONIZATION. Datta, R. N. (University Coll. of Science and Tech., Calcutta). J. Geophys. Res.; 77: No. 1, 260-2(1 Jan 1972).

Occurrence of sporadic-E ionization during the partial solar eclipse of 1955 over Haringhata is studied in the light of the present theory relating to internal gravity waves. It is found that the variation of fE_s indicates a periodicity that is inexplicable by the normal eclipse effect observed for regular ionospheric layers. From a critical study of the variation, tentative conclusion is drawn indicating that the enhancement of E_s ionization during the solar eclipse over this station may be related to internal gravity waves generated in the atmosphere from the fast-moving cooling spot of the shadow region. (auth)

13260 POSSIBILITY OF AURORAL SIMULATION. Podgornyi, I. M. (Inst. for Space Research, Moscow). J. Geophys. Res.; 77: No. 1, 270-2(1 Jan 1972).

Recent measurements show that the presence of magnetosheath-type particles in polar cusps support the auroral theories that direct plasma may penetrate into the magnetosphere. Even during stable boundary conditions, magnetosheath particles should penetrate into the magnetosphere through the neutral points and associated demarcation lines and then move in the Earth's magnetic field, precipitating into the atmosphere. Under real conditions, the penetration region cannot be limited to this domain alone, since in the vicinity of the neutral points there should be a rather extended portion of the magnetopause in which the field lines are concave outward. The role of the neutral points is investigated with the operation of a coaxial electrodynamical plasma accelerator where the electrons with energy ~10 keV appear simultaneously with the stream of plasma, apparently as a result of the same acceleration process in the high-power pulse discharge. The penetration of these energetic electrons through the neutral points is verified. (J.C.W.)

13261 VARIABILITY OF PLASMA-LINE ENHANCEMENT IN IONOSPHERIC MODIFICATION EXPERIMENTS. Fejer, J. A. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 77: No. 1, 273-5(1 Jan 1972).

The plasma line of the incoherent backscatter spectrum may be enhanced more than 3 orders of magnitude by the presence of a strong radio wave at 5.62 MHz. The enhancement occurs at the height of scattering of the 430-MHz radar echo when the radio-wave frequency of 5.62 MHz is between the local plasma and upper hybrid frequencies. A variability of the enhancement with time as well as with the orientation of the 430-MHz diagnostic radar beam occurs. An explanation is given for these variations. Plasma waves responsible for scattering the radar waves occur over a very limited range of heights. A tentative theoretical explanation is offered for the different strength of the upshifted and downshifted plasma lines, for the absence at certain times of the plasma line when the diagnostic beam is pointed 4° towards magnetic south from vertical, for complete absence of the plasma line at certain times and for fluctuations in strength of the line. These fluctuations in strength could be the result either of changes in the height gradient of electron density or of changes in the tilt of the layer; both of these changes would shift the position of the height of scattering with respect to nodes of the pump wave. (J.C.W.)

13262 COLLISIONLESS SOLAR WIND IN THE SPIRAL MAGNETIC FIELD. Chen, W. M.; Lai, C. S.; Lin, H. E.; Lin, W. C. (Univ. of Prince Edward Island, Can.). J. Geophys. Res.; 77: No. 1, 1-11(1 Jan 1972).

The two-fluid model for the solar wind of Hollweg (1970) is reconsidered with the inclusion of the spiral structure of the interplanetary magnetic field. In the present model, the protons are assumed to become collisionless beyond 0.1 AU from the Sun, whereas the electrons are treated hydrodynamically and the electron temperature is supposed to obey the polytropic law. The electric field established from the charge separation, which is assumed to be derivable from a potential, tends to enhance the velocity of the solar wind at 1 AU to a value over 300 km/sec. The proton thermal anisotrophy $T_{\parallel}/T_{\perp}$ at the orbit of the Earth is reduced from the value of 50 in the model with the radial magnetic field to the value of 11 in the present model. (auth)

13263 SOLAR-WIND SPEED VARIATIONS 1964-1967: AUTOCORRELATION ANALYSIS. Gosling, J. T. (National Center for Atmospheric Research, Boulder, Colo.); Bame, S. J. J. Geophys. Res.; 77: No. 1, 12-26(1 Jan 1972).

An autocorrelation analysis was performed on the Vela 2 and 3 solar-wind speed data obtained from July 1964 through December 1967 with two goals: to establish the degree to which speed structures recur from one solar rotation to the next, and to examine the duration and origin of "persistence" in the solar-wind speed. The average correlation between speed measurements separated in time by 1 solar rotation is 0.3, thus implying that most speed structures during the period under consideration do not endure for 28 days; however, the amplitude of the correlation varies with time from less than 0.1 to greater than 0.7. Differential solar rotation serves to weaken the correlation at any particular lag; the data suggest that a wide variety of solar latitudes contribute to the solar wind observed near the Earth. Recurrence periods ranging from about 27 to 29 days were observed; these periods differed from those determined from interplanetary-field measurements for the same interval by as much as a day. Correlations associated with the solar rotation are questionable after about August 1966; this fact may be related to increased solar activity associated with the advance of the solar cycle. High-speed streams are not the primary source of correlations between speed measurements separated by about 28 days; rather, low-speed (<400 km sec^{-1}) streams make the major contribution to the correlations observed. Those speed structures that do recur for more than 1 solar rotation have variable lifetimes, but few endure for more than 2 solar rotations. Measurements of the solar-wind speed separated by a day or less are usually highly correlated; the average correlation is 0.94 and 0.64 at lags of 3 hours and 1 day, respectively. It is found that this positive correlation, or persistence, extends out to about 3 days on the average; it is argued that about half this interval is the time over which the solar wind can be considered as "steady." Persistence is limited by both the spatial scale of coherent emission from the Sun and the temporal evolution of the solar atmosphere. It is suggested that 4 days is a typical time interval over which significant changes occur in the flow speed of the wind emanating from a particular region. (auth)

13264 STRUCTURE AND ORIENTATIONS OF SOLAR-WIND INTERACTION FRONTS: PIONEER 6. Siscoe, G. L. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res.; 77: No. 1, 27-34(1 Jan 1972).

Five stream–stream interaction events observed in the

Pioneer-6 plasma and field data are analyzed. That the time profiles of all the parameters are consistent among the events and with previous descriptions given in the literature substantiates the notion of a common interaction type. The velocity variations in four of the events tend to lie in planes approximately parallel to the corotation spiral; thus, it is implied that the events are reasonably stationary in time in the corotating frame. The data are interpreted in terms of a corotating interaction front, which is a ridge of high pressure parallel to a corotating spiral. The increased pressure is due to radial compression of the streams. The east–west (zonal) flow directions also occur in the front and are shown to be produced by the zonal pressure gradient of the pressure ridge. (auth)

13265 SOLAR-WIND STRUCTURE DETERMINED BY COROTATING CORONAL INHOMOGENEITIES. II. ARBITRARY PERTURBATIONS. Siscoe, G. L.; Finley, L. T. (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 1, 35-45(1 Jan 1972).

The problem of the solar-wind structure resulting from long-lived inhomogeneities in the solar corona was extended within the framework of a linearized hydrodynamic approach to allow for arbitrary perturbations in the plasma parameters, namely, velocity, density, and temperature. By using a Parker model for the zero-order flow speed, solutions are given for perturbations imposed at the zero-order critical point. Using the restriction that the solutions must be regular at the critical point, it is possible to express all situations as a linear sum of the solutions for pure velocity, density, and temperature perturbations at the critical point. The results of the integrations for the three inner-boundary conditions can be used as the elements of matrices that map arbitrary perturbations at one heliocentric distance to any other distance. One interesting feature of the solutions is that the amplitudes at Earth for the pure initial temperature situation are larger than for the other two situations. Thus, if the perturbation amplitudes at the critical point are all of the same order of magnitude, the temperature perturbation will dominate the structure at Earth. In fact, the phases between the perturbations at Earth given by the pure initial temperature situation are similar to the observations. (auth)

13266 EXCITATION AND PROPAGATION OF AN UPSTREAMING ELECTROMAGNETIC WAVE IN THE SOLAR WIND. Hasegawa, A. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Geophys. Res.; 77: No. 1, 84-90(1 Jan 1972).

Two types of circularly polarized hydromagnetic waves that can propagate upstream in the solar wind exist. One type is right-hand polarized with respect to the ambient magnetic field and has both its phase and group velocities directed upstream. It is a Doppler-shifted whistler mode that in a stationary frame has a much larger phase velocity than the solar-wind velocity. The other is left-hand polarized with respect to the ambient field and has its phase velocity directed downstream, but its group velocity is directed upstream. It is shown that the latter mode, which is also a Doppler-shifted whistler mode but which propagates backward in the moving frame, can be excited at the bow shock through a two-stream type instability between the solar wind and the magnetosheath plasma. The instability occurs around the local proton cyclotron frequency, and the generated wave can be convected upstream by this mode with a group velocity approximately equal to the solar-wind velocity. This instability, because of its scale size, is shown also to be a possible candidate for the shock formation. (auth)

13267 INTERNAL STRUCTURE OF THE GEOMAGNETIC NEUTRAL SHEET. Schindler, Karl (ESRIN, Frascati, Italy); Ness, Norman F. J. Geophys. Res.; 77: No. 1, 91-100(1 Jan 1972).

A study of the internal structure of the neutral sheet in the geomagnetic tail was made from data obtained by the NASA–GSFC magnetic-field experiment on the Explorer 34 spacecraft during its tail passage in the first half of 1968. The data used in the analysis are individual measurements of the vector magnetic field at 2.56-sec intervals. The experimental results consist of statistical studies of relevant properties of the magnetic field as a function of field magnitude. The results do not support nearly one-dimensional field models with characteristic lengths for field variation parallel to the neutral sheet much larger than the neutral-sheet width. The principal conclusion from the data points toward consistency with a quasi-periodic (possibly turbulent) structure with a tendency to formation of magnetic loops as one might expect from stability studies. Numerical results obtained using a simple model with a periodic field pattern in the field reversal region are compared with the observed internal structure. (auth)

13268 THEORY ON PRECIPITATION OF MAGNETOSPHERIC ELECTRONS AT TIME OF A SUDDEN COMMENCEMENT. Perona, G. E. (Politecnico, Turin). J. Geophys. Res.; 77: No. 1, 101-11(1 Jan 1972).

At the time of a sudden commencement or even of a sudden impulse, very-low-frequency waves can be excited. In turn, the wave turbulence drives the pitch-angle diffusion of energetic electrons trapped in the magnetosphere, causing them to be precipitated into the lower ionosphere. The distribution of this precipitation as a function of geomagnetic latitude and local time is shown to be directly related to the characteristics of the magnetic disturbances. (auth)

13269 CHANGES IN THE DISTRIBUTION OF LOW-ENERGY TRAPPED PROTONS ASSOCIATED WITH THE APRIL 17, 1965 MAGNETIC STORM. Burns, A. L.; Krimigis, S. M. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 77: No. 1, 112-30(1 Jan 1972).

The absolute intensity of geomagnetically trapped protons in the energy ranges $0.52 \leq E_p \leq 4.0$ and $0.90 \leq E_p \leq 1.8$ MeV was measured with the solid-state proton detector on the University of Iowa low-altitude (initial apogee 2502 km, perigee 527 km) high-latitude (inclination 81°) satellite Injun 4 for the period from March 1 to May 31, 1965. A study of the temporal variations of these fluxes associated with the April 17, 1965, magnetic storm (sc 1313 UT April 17, main phase onset ~0200 UT April 18) shows a general redistribution of these protons for $L \gtrsim 2.5$ and all sampled $|B|$ ranges, which persisted for at least 36 days after the storm. The effect of the sudden commencement was a general depression in the intensities and a hardening of the energy spectrums, although the intensities recovered to their prestorm level during the initial phase. The major redistribution was apparently initiated by the polar substorm that began at ~0620 UT on April 18 and continued long after (to 1100 UT) the substorm had subsided (~0800 UT). During the recovery phase, a secondary peak developed in the intensity profile at $L \sim 3.5$ for 0.52-MeV protons that had no counterpart at this energy at the equator (L. R. Davis, private communication, 1971). No such peak was observed for 0.9-MeV protons. The overall effect of the storm on the steady-state distribution was a nonadiabatic one with an increase in intensities at $L \lesssim 3$ and a decrease at $L \gtrsim 3$. The loss and/or gain of particles appear to be fractionally the same at all $|B|$ values sampled here. The post-storm dependence of the spectral parameter E_0 on L generally follows the relation $E_0 \propto L^{-3}$, although the prestorm dependence cannot be described by a simple function at all L values. The appearance of a secondary peak and the behavior of the prestorm and post-storm spectrums are in qualitative agreement with the predictions of the bimodal diffusion model of Theodoridis et al. [1969], whereby the solar wind is the source of the observed protons. (auth)

13270 IRREGULAR STRUCTURE OF THERMAL ION PLASMA NEAR THE PLASMAPAUSE OBSERVED FROM Ogo 3 AND Pc 1 MEASUREMENTS. Kikuchi, H.; Taylor, H. A. Jr. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 1, 131-42(1 Jan 1972).

Independent measurements of the plasmapause and associated thermal plasma structure from Ogo 3 are compared with ground-based Pc1 observations from the period 1966–67. Substantial agreement between the plasmapause crossings identified on the satellite and the Pc1 occurrence positions observed on the ground at midlatitudes during the nighttime (including dawn and dusk) indicates that these nighttime Pc1 events are closely associated with the plasmapause. A correlation of selected closely spaced events obtained in the nighttime under quiet to moderate activity ($Kp \leq 4$) provides good agreement in the proton concentrations near the plasmapause boundary. Examination of plasma fine structure reveals distinct plasma irregularities near the plasmapause in the afternoon–dusk local-time sector and at the other locations during the recovery phase of a magnetic storm. Preliminary results indicate Pc1 excitation is associated with plasma irregularities near the plasmapause and is particularly favorable in the region of "post-storm recovery" and in the region of diurnal "plasma bulge" in the afternoon-dusk sector. (auth)

13271 STORM-ASSOCIATED Pc5 MICROPULSATION EVENTS OBSERVED AT THE SYNCHRONOUS EQUATORIAL ORBIT. Barfield, Joseph N.; McPherron, Robert L.; Coleman, Paul J. Jr.; Southwood, David J. (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 1, 143-58(1 Jan 1972).

Quasi-sinusoidal magnetic-field oscillations (micropulsations) are regularly observed at ATS 1 during geomagnetic storms. The wave events typically occur during the main phase and tend to be confined to the afternoon sector. All observed events have been closely correlated with magnetospheric substorm activity. Power

spectral analysis shows that the observed oscillations are composed of harmonically related components. Twenty-six wave events were observed in 1967; the analysis of three typical Pc5 events is presented here. The observations are compared with the predictions of theory for a hot ($\beta \gtrsim 1$) inhomogeneous plasma. It is suggested that the observed micropulsations can be understood as the occurrence of either an Alfvén wave instability, or a drift instability, of the enhanced storm-time ring current. However, it is concluded that the proposed models require further refinement for a definitive explanation of the observations. (auth)

13272 RELATIONS BETWEEN GEOMAGNETIC MICROPULSATIONS AND MAGNETOTAIL FIELD CHANGES. Perkins, David M.; Watanabe, Tomiya; Ward, S. H. (Univ. of California, Berkeley). J. Geophys. Res.; 77: No. 1, 159-71(1 Jan 1972).

The magnetic field in the tail region observed by the Imp-1 satellite was compared with geomagnetic-micropulsation activities detected by ground-based observations at Ralston, Alberta, Canada. The tail-field strength was found to decrease, typically by one to a few gammas, in simultaneity with the onset of a Pi2 micropulsation activity detected on the ground. Several tens of such examples were obtained during continuous rapid-run micropulsation observations for about a week. During the same time interval, four Pc3 micropulsation events took place with clearly identifiable onsets—an unusual feature for Pc3. The tail field followed a characteristic pattern of evolution in each of the four events. In a period of about one-half hour to one and one-half hours before a Pc3 onset the tail-field strength gradually built up, and with the onset it abruptly decreased by several gammas. Whereas a sudden onset-time decrease in the tail-field strength is common to Pi2 and Pc3, Pc3 activity is found to diminish in sympathy with a gradual tail-field decrease over a time of about twenty minutes or more, provided that the tail-field decrease exceeds about ten gammas. (auth)

13273 VLF HISS AND RELATED PLASMA OBSERVATIONS IN THE POLAR MAGNETOSPHERE. Gurnett, D. A.; Frank, L. A. (Univ. of Iowa, Iowa City). J. Geophys. Res.; 77: No. 1, 172-90 (1 Jan 1972).

A study of auroral-zone vlf hiss and low-energy charged-particle observations with the Injun-5 satellite is presented. The results of this study provide a direct verification of the association between auroral-zone vlf hiss and intense fluxes, 10^4 to 10^7 electrons $(cm^2\ sec\ ster\ eV)^{-1}$, of low-energy electrons with energies on the order of 100 eV to several keV. On the dayside of the magnetosphere, these low-energy electrons are identified with the dayside polar-cusp region observed at higher latitudes with the Imp-5 satellite. At other local times, through the dawn and dusk regions and into the nightside of the magnetosphere, the vlf hiss and low-energy electron precipitation regions are believed to correspond to the extension of the dayside polar cusp into the distant plasma sheet and downstream magnetosheath on the nightside of the magnetosphere. Intense fluxes of upgoing electrons are often observed in a narrow latitudinal band near the low-energy electron precipitation bands. These upgoing electrons are believed to be associated with another type of vlf emission called a saucer, which is frequently observed with Injun 5. On the basis of present models, the observed vlf hiss intensities cannot be accounted for by incoherent Cherenkov radiation from the observed electron fluxes, thus indicating that coherent plasma instability mechanism is involved in some, if not all, of the vlf hiss generation. A model for the generation regions of vlf hiss and saucer emissions is discussed. (auth)

13274 OBSERVATIONS OF MAGNETIC-FIELD-ALIGNED AURORAL-ELECTRON PRECIPITATION. Whalen, B. A.; McDiarmid, I. B. (National Research Council of Canada, Ottawa). J. Geophys. Res.; 77: No. 1, 191-202(1 Jan 1972).

A sounding rocket was launched in the early evening into an auroral display during a 50-γ positive bay. The flight path carried the rocket over the two most northerly arcs in a band of parallel east–west oriented arcs, into a region of low activity to the north of the band, and then into a large fold northeast of the launch site. Several times during the flight, intense field-aligned electron pitch-angle distributions (i.e., peaked near 0°) were observed; these regions were found to be coincident with the northern boundary of the band of auroral precipitation. No equivalent distributions were observed between arcs to the south. Electron intensities of about 10^{11} $(cm^2\ sec\ ster\ keV)^{-1}$ peaked near $\beta = 0$ were observed at 0.55 keV and electrons near this energy were conservatively estimated to carry a current of 2×10^{-4} amp/m^2. This electron current sheet was estimated to have a large east-west extent and a north–south thickness of 10 km, and under certain conditions would produce a transverse magnetic field of $10^3\ \gamma$. Field-aligned 7.8-keV electrons were also observed in the boundary region with intensities in the flight. Energetic electron (E > 25 keV) pitch-angle distributions were found to be generally anisotropic peaked near 90°; however, at times of maximum intensities, the distributions approached isotropy. Energetic proton (E > 30 keV) intensity profiles obtained during the flight were featureless, and pitch-angle distributions were anisotropic, peaked near 90°. No correlation with electron intensities was apparent; however, the proton pitch-angle distributions gradually shifted toward isotropy on two occasions of intense electron precipitation (near the center of the arc). This minor correlation was not considered statistically significant. Low-energy ion precipitation was below the limit of detectability, and an upper limit on the primary ion beam was set at 5×10^5 $(cm^2\ sec\ ster\ keV)^{-1}$ and the 1- to 20-keV energy range. Most characteristics of particle precipitation observed in the boundary region are shown to be consistent with a local acceleration from a parallel electric field with a potential drop greater than 7 kV. (auth)

13275 DIURNAL AND SEASONAL MODEL OF THE F1 LAYER AT MEDIUM TO HIGH LATITUDES. Torr, D. G. (South African Council for Scientific and Industrial Research, Johannesburg); Torr, Marsha R.; Laurie, D. P. J. Geophys. Res.; 77: No. 1, 202-11(1 Jan 1972).

A model of the F1 layer is set up with a basic structure essentially the same as an E-layer model recently published by Keneshea, Narcisi, and Swider. The models yield almost identical results for the same input parameters. Using the model in this form, observed and calculated diurnal variations of electron density at Sanae (70°S, 2°W, L = 4) are compared for heights from 120 to 200 km for selected days during the 6-month period June to December 1966. The first continuous solution of the ion concentrations O^+, O_2^+, NO^+, and N_2^+ for a high-latitude station is presented. It is found that fair agreement in electron plasma frequency (within a factor of 2) is obtained after about November 4. The agreement becomes steadily worse as one draws nearer to winter, and the model is totally inadequate to explain the bulk of ionization observed in the F_1 layer in winter. Because several recent papers have reported large fluxes of low-energy electrons both at middle and high latitudes, an estimate is made of the electron fluxes and energy spectra that would be required to explain the diurnal densities observed on 1 day in June (29) and on 1 day in November (4). Energy fluxes are of the same magnitude as observed by Schield and Frank. The energy spectrum is also of the form $\exp(-E/E_0)$, becoming harder towards midday. In winter $E_0 \approx 0.25$ keV and in summer ≈ 1 keV. This hardening of the spectrum from winter to summer is consistent with observations. It is found that the total energy flux at midday and midnight does not change with season. These results are consistent with N_2^+ emissions observed at Sanae. (auth)

13276 ROCKET-BASED VECTOR MAGNETIC MEASUREMENTS OF Sq IONOSPHERIC CURRENT NEAR SPORADIC E. Cloutier, P. A.; Sandel, B. R. (Rice Univ., Houston, Tex.). J. Geophys. Res.; 77: No. 1, 212-23(1 Jan 1972).

A rocket-borne vector magnetometer was used to infer the current magnitude, direction, and distribution of midlatitude ionospheric currents near sporadic E. The payload, comprising a scalar magnetometer with bias coil and a solar-aspect sensor for determining vehicle attitude, was launched via a Nike–Apache sounding rocket from Wallops Island, Virginia, at 0705 local time (1205 UT) on August 7, 1968. Complete vector information returned throughout the flight indicates that a southward equivalent surface current (vertically integrated current) of 0.15 amp/m was encountered between the altitudes of 104 and 118 km in both ascending and descending portions of the flight. Vertical distribution of the current within the layer was approximately uniform, and the layer was found to be horizontal within the accuracy of the experiment. The data are consistent with the assumption that a sporadic-E layer observed by Wallops Island ionosondes significantly altered the usual Sq current flow pattern by concentrating the current into a narrow altitude range, and by horizontally focusing the current flow into the sporadic-E region with attendant reduction of current density outside the region. Such an effect is discussed in relation to previous theoretical work. (auth)

13277 RADIAL DIFFUSION OF TRAPPED PARTICLES INDUCED BY FLUCTUATING MAGNETOSPHERIC FIELDS. Walt, Martin (Lockheed Palo Alto Research Lab., Calif.). Space Sci. Rev.; 12: No. 4, 446-85(Nov 1971).

Small fluctuations in magnetospheric electric and magnetic fields lead to random changes in the radial positions of trapped particles. The characteristics of this radial diffusion are described theoretically in terms of the statistical properties of the field fluctuations, in particular the power spectra of the various spatial components. A large body of trapped-particle data demonstrates that diffusion with the predicted properties actually takes place. These data include the average radial and energy distributions and the time variations in particle

fluxes. This radial diffusion has a major influence on the structure of the radiation belts; and since the net flow of particles is inward at most positions of the magnetosphere, the process acts as a strong source of trapped particles. Further experiments are needed to establish the importance of this mechanism relative to magnetic storm effects and to collective instabilities. 63 references. (auth)

13278 MODULATION OF AURORAL ELECTRON PRECIPITATIONS. Bosqued, J. M.; Gasquet, J. C.; Reme, Henri (Univ., Toulouse). Compt. Rend., Ser. B; 273: No. 18, 805-8(3 Nov 1971). (In French).

Direct measurements made on diffuse auroral electrons revealed the presence of two components: electrons with energies between 5 and 30 keV, whose dynamics agree with heavy pitch-angle scattering mechanism near to the equatorial plane; electrons with energies between 0.5 and 5 keV having anisotropic angular distributions around the periphery of the loss cone when the bursts occur. These distributions, which are linked to energy-dependent flux modulations, may be explained by a resonance at the rebound frequency mechanism. (France)

13279 TWO-BODY MUTUAL NEUTRALIZATION RATES OF $O_2^+ + O^-$, $NO^+ + O^-$, AND $Na^+ + O^-$ OBTAINED WITH MERGED BEAMS. Moseley, John T.; Aberth, William; Peterson, James R. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res.; 77: No. 1, 255-9(1 Jan 1972).

Two-body ion-ion neutralization rates were measured by the merged-beam technique for $O_2^+ + O^-$, $NO^+ + O^-$, and $Na^+ + O^-$ at well-defined energies in the range 0.15 to 20 eV. At barycentric energies above 1 eV, the rates are relatively constant and have respective values of about 6×10^{-8}, 12×10^{-8}, and 5×10^{-8} cm^3/sec. For energies below 1 eV, the rates rise monotonically as is typical for these reactions. The data have been extrapolated to lower energies and averaged over a Boltzmann energy distribution to yield thermal reaction rates at 300°K of $(10 \pm 4) \times 10^{-8}$, $(49 \pm 20) \times 10^{-8}$, and $(21 \pm 10) \times 10^{-8}$ cm^3/sec for $O_2^+ + O^-$, $NO^+ + O^-$, and $Na^+ + O^-$, respectively. (auth)

13280 MEASUREMENTS OF THE MASS AND MOBILITY OF SMALL IONS IN AIR. Huertas, M. L.; Marty, A. M.; Fontan, Jacques (Toulouse Univ.). Compt. Rend., Ser. B; 272: No. 23, 1289-92(7 Jun 1971). (In French).

Ions in air were studied using an apparatus which permitted measurements to be made of the mobility and mass of ions created in an enclosure, whose pressure varied between a few torr and 40 torr. These measurements demonstrated a progressive agglomeration of ions, and led to the determination of the mass of small ions in air in terms of their mobility. (France)

For abstracts of individual chapters see: 13213, and 13282-13296.

13281 ISSLEDOVANIE IONOSFERY. (Studies of the Ionosphere). Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). 296p.

Abstracts were prepared for 16 chapters. The five remaining chapters discuss instrumentation or resultant records from instrumentation and are out of scope for NSA. (J.C.W.)

13282 DIFFUSION OF CHARGED PARTICLES IN THE F REGION OF THE IONOSPHERE. Polyakov, V. M. pp 3-63 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

A short survey was made concerning the influence of diffusion on the vertical distribution of electrons and ions in the ionospheric F region. Attention was limited to one-dimensional diffusion under the action of a pressure gradient in a gravitational field in the presence of homogeneous and nonhomogeneous geomagnetic fields in an ambipolar approximation. The structure of the diffusion flux and the characteristics of its sources were studied in detail under stationary conditions with a homogeneous geomagnetic field. It is noted that the F2 layer at midlatitudes forms in an incident flux of an electron-ion gas. The daytime maximum of this layer is governed by the height of the photochemical equilibrium level, while the nighttime maximum depends on equilibrium between neutralization and ionization. The diffusion of certain positive ions that comprise a small part of the electron-ion gas was examined, and attention was given to works concerned with the effects of diffusion on the diurnal variations in electron concentration. Data were given for the divergence of the diffusion flux at various F-region heights during different times of day. 64 references. (IAA)

13283 ION COMPOSITION AND VERTICAL DISTRIBUTION OF CHARGED PARTICLES IN THE IONOSPHERIC F REGION AND IN THE PROTONOSPHERE (SURVEY). Kutimskaya, M. A.; Polyakov, V. M. pp 64-89 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

A survey was made of satellite and ground-based observations of the ion composition and vertical distribution of charged particles in the ionospheric F region and in the protonsphere. The molecular NO^+ and O_2^+ ions predominate below heights of 200 to 150 km, while the relative content of O^+ increases rapidly above 200 km. The relative concentration of NO^+ increases from day to night, while the O^+ content decreases at night. The variation of electron concentration is examined in geomagnetic coordinates, and the relation between the equatorial anomaly and magnetic force lines is analyzed. Strong changes in the vertical electron-concentration profile above the F2 maximum are shown to be a function of solar activity. The electron concentrations and the height scale of the electron-ion gas above the F2 maximum have a clearly evident diurnal behavior. 91 references. (IAA)

13284 ELECTRON TEMPERATURE IN THE ALTITUDE INTERVAL FROM 500 TO 1000 km AS DETERMINED FROM N(h) PROFILES OBTAINED ON THE BASIS OF THE ALOUETTE SATELLITE DATA. Kutimskaya, M. A. pp 90-3 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

Calculations were made of the electron temperature at heights from 500 to 1000 km during minimum solar activity, using Alouette-satellite data and an atmospheric model of Harris and Priester (1962). The results show that electron temperature increases with latitude. This latitudinal variation of electron temperature is caused by solar uv radiation. The diurnal electron-temperature maximum is observed in the morning hours. No variation of electron temperature with height was observed above 500 km. (IAA)

13285 BEHAVIOR OF THE PARAMETER $\delta = H_m H_i$ IN THE RANGE OF HEIGHTS FROM THE F2-LAYER MAXIMUM TO 1000 km. Kutimskaya, M. A.; Polyakov, V. M. pp 94-7 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian)

An investigation was made of the time and altitude dependences (in the range from 340 to 1000 km) of the parameter $\delta = H_m/H_i$ where H_m is the height scale of neutral gas and H_i is the height scale of the electron-ion gas. It is shown that the δ parameter does not vary more than 5% with height and 20% with time. As a result, the introduction of this parameter into the diffusion equation made it possible to consider the diffusion coefficient constant for stationary conditions. For the case of nonstationary conditions, it is necessary to account for the temporal variations of the δ parameter. (IAA)

13286 POSSIBILITY FOR THE EXISTENCE OF TWO PHOTOIONIZATION-RATE MAXIMA IN THE IONOSPHERIC F REGION. Shchepkin, L. A.; Sidorova, S. G. pp 98-106 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

An investigation was made of the twin-peak profile of the photoionization rate as a function of height in the presence of a temperature maximum at F-region levels. Such a complex profile was previously demonstrated for the ionization of one of the atmospheric gases by quasi-monochromatic radiation. An attempt is made to determine whether this occurs for all the main atmospheric constituents during ionization by radiation containing a large number of spectral lines. Expressions are given that make it possible to estimate the presence of ionization function extrema with allowance for the three main atmospheric components in different spectral lines. Using certain atmospheric models that involve the presence of a temperature maximum in the F region, it is shown that the formation of two ionization function maxima is possible in a number of different spectral intervals of the ionizing radiation. The effect is particularly strongly expressed during the ionization of atomic oxygen. (IAA)

13287 CYCLIC VARIATIONS IN CONDITIONS FOR DEVELOPMENT OF THE F1 LAYER AT MIDLATITUDES. Sidorova, S. G. pp 107-13 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

An investigation was made of the parameters characterizing the development of the F1 layer at midlatitudes as a function of mean monthly Wolf numbers, using data obtained in Moscow and Irkutsk during the period from 1948 to 1964. Results show a sys-

tematic reduction in the cos x value for the seasonal onset of the F1 layer with reduced solar activity. The dependence of the mean daily probability of F1 occurrence as a function of the Wolf number during March shows a reduced probability of occurrence with increasing solar activity. In June, this tendency is evident only for parameters of the clearly defined F1 layer. (IAA)

13288 LATITUDINAL VARIATIONS OF IONIZATION–RECOMBINATION PARAMETERS. Nikanorova, R. Sh.; Shchukina, T. B. pp 114-23 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

The determination of ionization–recombination parameters was made on the basis of data for diurnal variations of the electron concentration in the F2-layer maximum. The parameters were determined with the aid of an analog computer used to solve a system of continuity equations for electrons and molecular ions. For 19 points within latitude intervals between 30 and 60° in the northern and southern hemispheres, noontime ionization rates were determined along with the product of the dissociation recombination rate and the molecular ion concentration. The product of the ion–molecule reaction coefficient by the concentration of the molecular component concentration was also determined. The maximum values of the recombination parameters are obtained for the interval between 40 and 45°. (IAA)

13289 SEASONAL AND CYCLIC VARIATIONS OF THE IONIZATION–RECOMBINATION PARAMETERS. Shchukina, T. B. pp 124-30 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

An investigation was made of the variation of ionization–recombination parameters as a function of season and solar activity, using data for diurnal changes of electron concentration in the F2-layer maximum over Irkutsk. Parameters appearing in the system of ionization balance equations were determined, including the effective rate coefficients of ion–molecule processes and of dissociative recombination, the intensity of the ionizing radiation flux, and the noontime values of the ionization rates. (IAA)

13290 INVESTIGATION OF SCATTERED REFLECTIONS IN MAGNETICALLY CONJUGATE POINTS. Kazimirovskii, E. S.; Kokourov, V. D. pp 131-9 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

A short survey of theories relating the dynamics of the magnetosphere with the formation of an inhomogeneous electron density in the ionospheric F region was presented. Attention is given to diurnal variations in the frequency of occurrence and the intensity of F-layer scattering in magnetically conjugate points. Emphasis is placed on the latitudinal behavior of the phenomenon. The variations in the parameters characterizing the irregular ionospheric structure are shown to be related in magnetically conjugate points at low geomagnetic latitudes; no evident relation exists at higher latitudes. (IAA)

13291 F-SCATTERING AND SHORT-PERIOD OSCILLATIONS OF THE EARTH'S ELECTROMAGNETIC FIELD ON THE BASIS OF OBSERVATIONS AT IRKUTSK. Vergasova, G. V.; Kokourov, V. D. pp 140-6 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

Preliminary results were given of a study aimed at determining the relationship between F-layer scattering and pearl pulsations. Amplitude-frequency and correlation analyses were performed, and the durations and intensities of the phenomena are compared. A relationship is established between electron density and both the amplitude and the probability of occurrence of pearl pulsations. The frequency of occurrence of both the pearl pulsations and F scattering is largest when the layer is high and electron densities are low. The probability of occurrence of pearl pulsations is highest when electron density is 375,000 electrons/cm^3. (IAA)

13292 RELATION BETWEEN THE ELECTRON CONCENTRATION AT HEIGHTS OF 100 AND 110 km AND THE DISTURBANCE OF THE EARTH'S MAGNETIC FIELD. Korsunova, L. P.; Mishin, V. M.; Ivanov-Kholodnyi, G. S.; Kazachevskaya, T. V. pp 147-55 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

An analysis was made of the changes in the electron concentration in the lower E region of the ionosphere, and their association with geomagnetic-field disturbances. It is shown that the daytime electron concentration increases roughly two times at 100 km and 1.5 times at 110 km at midlatitudes for K = 3 to 5 (where K is the 3-hour index, whose changes characterize in the first approximation the variations of the geomagnetic field). The intensity of the flux of the additional ionizing radiation responsible for the observed increase in electron concentration is evaluated. 31 references. (IAA)

13293 FREQUENCY DEPENDENCE OF ABSORPTION (SURVEY). Kalinovskaya, G. P. pp 156-67 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

Data obtained by pulse techniques were correlated with the dependence of radio-wave absorption on the sounding frequency at vertical incidence. Particular attention is given to the seasonal and latitude variations of the frequency dependence. The importance of considering the influence of wave reflection from the sporadic-E layer on the results of absorption measurements is noted. The dependence of absorption on the lowest reflection frequency in vertical sounding is also studied. Methods of discriminating between deflected and nondeflected absorption (measured by the A1 and A2 methods), based on the use of an empirical relation between frequency and absorption, are examined. 41 references. (IAA)

13294 INFLUENCE OF KINETIC PARAMETERS ON DIURNAL VARIATIONS OF ELECTRON CONCENTRATION IN THE F2 LAYER MAXIMUM. Guterman, B. S.; Polyakov, V. M. pp 168-77 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

An analysis was made of a system of continuity equations for an electron–ion gas in the ionosphere as a function of changes in the basic parameters: ionization intensity and the rate coefficients of dissociative recombination and ion–molecule reactions. It is shown that the features of individual segments of the electron density variation curve in the F2 maximum can be related to a predominating influence by one of the three basic parameters. For example, the depth of the pre-dawn minimum and the steepness of the morning growth in electron concentration are controlled by the rate coefficient of ion–molecule processes, while the value of maximum concentration is governed by the ionization intensity. (IAA)

13295 POSSIBILITIES OF THE METHOD OF PANORAMIC VERTICAL SOUNDING OF THE IONOSPHERE. Kokourov, V. D.; Galkin, A. I. pp 181-91 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

A critical analysis was made of panoramic vertical sounding, showing that the method is imperfect both in its principle and technological means. A major drawback of the method is that as little as 3.5% of experimentally obtainable data on the state of the ionosphere are obtained at the respective ionospheric station. Some means of improving the current status of ionospheric stations are suggested. (IAA)

13296 NEUTRALIZATION OF THE ELECTRON–ION GAS IN THE F REGION OF THE IONOSPHERE. Polyakov, V. M.; Shchukina, T. B. pp 236-84 of Issledovanie Ionosfery. /Sokolov, A. K. (ed.). Novosibirsk, USSR; Izdatel'stvo Nauka Sibirskoe Otdelenie (1970). (In Russian).

Chemical reactions responsible for the neutralization of the electron–ion gas in the F layer are discussed. The mechanism of recombination in the ionosphere and the kinetics of the ion gas are also studied. It is shown that the F2 layer is created and maintained under conditions of a variable effective recombination coefficient (capable of rapidly varying with time). This variation is attributed to changes in the content of molecular ions in the atmosphere, and is particularly pronounced in the early morning hours, when the sunrise molecule–ion content is initially small and varies rapidly under nonequilibrium conditions associated with abrupt changes in the illumination of the atmosphere. Further, it is shown that the characteristics of the diurnal and seasonal variations in the electron concentration in the maximum of the F2 layer are defined to a great extent by recombination processes. This is most evident during periods characterized by rapid variation of the ionization function. The neutralization conditions in the F1 layer are close to equilibrium. The large relative content of molecular ions leads to high values for the effective recombination coefficient. (IAA)

Low-Temperature Physics and Cryogenic Equipment

Refer also to abstract 14336.

13297 HELIUM SOCIETY. Symposium Proceedings, Washington, D. C., May 3–4, 1971. Blizin, Jerald (comp.). Washington, D. C.; Helium Society (1971). 335p. (CONF-710528).

Fourteen papers on the properties, handling, and uses of helium were presented at the conference and are included in this issue. A separate abstract was prepared for each of four papers. Ten papers were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 11929, 13318, 14334, and 14459.

Superfluidity

Refer also to abstracts 12938 and 13467.

13298 INTERACTING ROTONS AND SUPERFLUIDITY IN LIQUID HELIUM. Ruvalds, J. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 27: No. 26, 1769-71(27 Dec 1971).

A theory based on roton–roton interaction is developed for the superfluid phase transition in liquid helium. The roton coupling causes a decrease of the roton energy with increasing temperature; thus, the roton exhibits a soft-mode behavior, in common with other second-order phase transitions. The calculated superfluid density is in remarkable agreement with experiment, and the roton softening is consistent with recent neutron data. (auth)

13299 HELIUM-II NOISY FILM BOILING AND SILENT FILM BOILING HEAT TRANSFER COEFFICIENT VALUES. Leonard, A. C. (Royal Military Coll. of Canada, Kingston, Ont.). pp 109-14 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The existence of two distinct modes of film boiling in helium-II was established: noisy film boiling and silent film boiling. With noisy film boiling the sound is similar to that of cavitation or nucleate boiling in a subcooled conventional liquid and is thought to result from the rapid collapse of the vapor film. High-speed (5000 fps) motion pictures support this view. They show that similar to nucleate boiling in conventional liquids the disturbance adjacent to the heater is much greater with noisy film boiling than with silent film boiling; however, in striking contrast to normal fluids, this increased activity increases the resistance to heat flow. A second type of noise near the λ point was encountered. This noise increases the rate of heat flow and is due, perhaps, to the localized formation of helium-I in which nucleate boiling occurs. Values of the heat transfer coefficient during silent and noisy film boiling were obtained. The data are presented in graphical form as a function of the helium-II bath temperature. The increase in the resistance to heat flow upon passing from noisy to silent film boiling was found, in some cases, to be more than 30%. From the experimental data, three boiling regimes were identified on a graph of immersion depth versus bath temperature. (auth)

13300 NEW SUPERLEAKS. Goldschvartz, J. M.; Martin, E.; Blaisse, B. S. (Delft Univ. of Tech., Netherlands). pp 496-7 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Two new natural materials that behave as good superleaks for superfluid helium are described. One is wonderstone, an aluminum silicate from South Africa, and the other is a talc-stone from Rabenwald, Austria, which is a magnesium silicate. The onset points of natural samples of these two minerals are 2.05 and 1.69 K, respectively. (auth)

Superconductivity

Refer also to abstracts 12609, 12685, 13430, and 13431.

13301 CRITICAL MAGNETIC FIELDS OF A KONDO SUPERCONDUCTOR: ZnMn. Smith, F. W. (Rutgers–The State Univ., New Brunswick, N. J.). J. Low Temp. Phys.; 5: No. 6, 683-99 (Dec 1971).

The superconducting critical fields of pure Zn and of a series of ZnMn alloys were measured as a function of temperature T down to 0.06 K. The critical fields were used to calculate the entropy difference between the normal and superconducting states. For all the alloys studied, the entropy in the superconducting state is proportional to T as $T \to 0$, indicating a finite density of states at the Fermi energy. This result is interpreted as evidence for the existence of localized bound states within the energy gap centered at the Mn impurities. Results obtained for the depression of T_c, for the critical field at $T = 0$, for the jump in specific heat at T_c, and for the law of corresponding states are also presented and compared with the predictions of the Abrikosov–Gor'kov theory. A simple expression relating the critical fields of these alloys to the Mn concentration was found to be in very good agreement with experiment. (auth)

13302 EFFECT OF THERMAL PHONON PAIR BREAKING ON SUPERCONDUCTING FLUCTUATIONS. Crow, J. E. (Brookhaven National Lab., Upton, N. Y.); Bhatnagar, A. K.; Mihalisin, T. Phys. Rev. Lett.; 28: No. 1, 25-7(3 Jan 1972).

Previous experimental measurements of the paraconductivity for various materials show varying degrees of agreement with the Aslamazov–Larkin theory. These measurements indicate that this behavior can be understood if one includes the Maki–Thompson fluctuation term with a thermal pair-breaking interaction plus an additional pair-breaking parameter proportional to the resistance per unit area of the film. (auth)

13303 TIN WHISKER WITH TWO INDEPENDENT SUPERCONDUCTING PHASE DIAGRAMS. Rothberg, B. D.; Nabarro, F. R. N.; McLachlan, D. S. (Univ. of the Witwatersrand, Johannesburg). J. Low Temp. Phys.; 5: No. 6, 665-81(Dec 1971).

Whiskers grown by extrusion from tin plate are known to have irregular cross sections; one such whisker could be regarded as a cylinder of approximately 2 μ in diameter, attached to which, with its plane parallel to the cylinder axis, was a thin film of an approximate thickness of 1000 Å. The superconducting transition of this whisker was studied resistively as a function of magnetic field, temperature, and elastic strain, and is interpreted in terms of two independent phase diagrams, one being attributed to the cylinder and one to the thin film; size effects are discussed. It seems that the cylinder and the thin film behaved as two separate systems in parallel, allowing, for example, the coexistence of a stable superconducting state in the film and a metastable normal state in the cylinder. (auth)

13304 THEORY OF ac LOSS IN TYPE-II SUPERCONDUCTORS IN THE MEISSNER STATE. Melville, P. H. (Central Electricity Research Labs., Leatherhead, Eng.). J. Phys., C (London); 4: No. 17, 2833-48(Dec 1971).

The problem of ac loss in the Meissner state of Type-II superconductors is examined theoretically by considering the field enhancement and consequent flux penetration at surface irregularities. A rough estimate of the loss can be made with little difficulty, but to study the problem in more detail the Lorentz force, $[-\phi_0 \times \text{curl } H(B,x)]$ is equated with the pinning force on the fluxons. This gives the flux gradient as a function of flux density and position. Numerical integration is necessary to obtain the flux distribution and hysteresis loss, but the final results are in good agreement with experiment, and show that the loss is dependent upon the shape, the purity, and to a lesser extent, the metallurgical state of the surface region. The low-frequency motion of small quantities of flux trapped in the superconductor perpendicular to the surface is also examined, and the contribution to ac loss determined. (auth)

13305 EVIDENCE FOR SPLITTING OF PHONON STRUCTURES IN SINGLE-CRYSTAL Pb TUNNELING. Blackford, B. L. (Dalhousie Univ., Halifax, N. S.). Phys. Rev., B; 5: No. 3, 1171-4(1 Feb 1972).

Experimental evidence is presented which shows that the two energy gaps appearing in the tunneling characteristics of superconducting Pb crystals have a discernible splitting effect on some of the transverse phonon peaks. This is in agreement with our earlier observations but disagrees with the recent results of Leger and Klein. (auth)

13306 SUBHARMONIC STRUCTURE IN TUNNEL JUNCTIONS BETWEEN DISSIMILAR SUPERCONDUCTORS. Bermon, Stuart; Mesak, R. M. (Brown Univ., Providence). Solid State Commun.; 9: No. 23, 2143-6(1 Dec 1971).

Subharmonic structure in the dV/dI vs. V characteristic of superconducting tunnel junctions composed of tin and bulk mercury separated by an artificial barrier of amorphous germanium was identified at voltages corresponding to the even and odd series of Werthamer. The situation is complicated however by the presence of other structure in the curves, some at voltages corresponding to unpredicted series. The problem of the proper identification of subharmonic structure is discussed. (auth)

13307 THICKNESS DEPENDENCE OF THE PERPENDICULAR CRITICAL MAGNETIC FIELDS OF Pb/Cu DOUBLE LAYERS. Martinoli, P.; Meraldi, J. P. (Swiss Federal Inst. of Tech., Zurich). Solid State Commun.; 9: No. 23, 2123-7(1 Dec 1971).

The proximity effect of a normal metal (Cu) on the perpendicular

critical magnetic fields $H_{c\perp}$ of superconducting Pb-films was investigated. Special attention was developed to the dependence of $H_{c\perp}$ on the thickness of the superconducting layers. The experimental results are compared with calculations based on the Ginzburg–Landau theory. (auth)

13308 SELF-CONSISTENT ELECTRON–PHONON COUPLING IN THE TIGHT-BINDING APPROXIMATION. II. Barisic, S. (Laboratoire de Physique des Solides, Orsay, France). Phys. Rev., B; 5: No. 3, 941-51(1 Feb 1972).

The validity of the rigid-atom model for electron–phonon coupling in the tight-binding approximation is examined within the linearized self-consistent theory. It is shown that the deformation-induced charge-density wave will generally reduce the strength of the coupling, thus reducing the Kohn anomaly in the phonon spectrum and the superconducting transition temperature computed from the rigid-atom model. The charge-density wave does not appear for certain modes; the optimal situation is that of the (nearly) half-filled band, when the rigid-atom model gives approximately correct results. (auth)

13309 RIGID-ATOM ELECTRON–PHONON COUPLING IN THE TIGHT-BINDING APPROXIMATION. I. Barisic, S. (Laboratoire de Physique des Solides, Orsay, France). Phys. Rev., B; 5: No. 3, 932-41(1 Feb 1972).

The intraband electron–phonon coupling, calculated in the tight-binding approximation, is derived from an effective deformation potential. This coupling agrees with expressions obtained by previous authors. The potential reduces to the Bardeen–Shockley deformation potential and to the Longuet–Higgins–Salem result in the long-wavelength and short-wavelength limits, respectively. The phonon-induced d–d coupling alone is shown to account for the order of magnitude of the superconducting transition temperature in transition metals. The McMillan procedure for the computation to the superconductive coupling is analyzed in the case when the Fermi level falls close to a pronounced Van Hove singularity in the electron density of states. In this case the behavior of the density of states n may dominate the behavior of the product nV, where V is the electron–electron effective interaction. (auth)

13310 COMPARISON OF SPECIFIC HEAT MEASUREMENTS AND TUNNELING DATA OF DISORDERED Pb- AND Pb–Bi FILMS. Happel, H.; Knorr, K.; Barth, N. (Univ., Frankfurt am Main). Z. Phys.; 249: No. 2, 185-8(1971).

Disordered superconducting Pb- and Pb + 30% Bi-films are investigated by electron tunneling. Results are critically compared with experimental specific heat data reported recently by Ewert and Sander [Z. Phys. 247: 21(1971)]. The low-frequency phonon densities of states $F(\omega)$ are found to be enhanced for amorphous films. (auth)

13311 CHARGE CONSERVATION AND CHEMICAL POTENTIALS IN TIME-DEPENDENT GINZBURG–LANDAU THEORY. Rieger, T. J. (Univ. of California, Santa Barbara); Scalapino, D. J.; Mercereau, J. E. Phys. Rev. Lett.; 27: No. 26, 1787-90 (27 Dec 1971).

A phenomenological, charge-conserving, time-dependent Ginzburg–Landau theory is found to lead to a charge density and a difference between the quasi-particle electrochemical potential and the pair electrochemical potential, when there is a divergence of the supercurrent. Experimental consequences are discussed. (auth)

13312 LOW-TEMPERATURE PHASE TRANSFORMATION IN Nb–Ge–Al ALLOY. Kodess, B. N. (Inst. for Solid State Physics, Chernogolovka, USSR); Kuritzin, V. B.; Tretyakov, B. N. Phys. Lett.; 37A: No. 5, 415-16(20 Dec 1971).

A cubic-to-tetragonal transformation is discovered in the Nb_3(Al–Ge) alloy (Ge/Al = 3) as a result of an investigation carried out at low temperatures by means of an x-ray and NMR analysis. (auth)

13313 INTERACTION OF DISLOCATIONS WITH PINNING CENTERS IN NORMAL AND SUPERCONDUCTING LEAD. Platkov, V. Ya.; Polunina, L. N.; Startsev, V. I. (Physical-Technical Inst. of Low Temperatures, Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 7, 1577-81(Jan 1972).

Translated from Fiz. Tverd. Tela; 13: No. 7, 1881-7(Jul 1971).

The internal friction was measured at 7.5 MHz as a function of amplitude in normal and superconducting lead. An amplitude dependence is observed both in the normal and superconducting states and takes the form of a curve with saturation; in the superconducting state the saturation occurs for a substantially lower amplitude than in the normal state. In the superconducting state the temperature affects the amplitude-dependent part of the absorption coefficient, while in the normal state it has no effect. The results show that during the superconducting transition, there is a change in the conditions for depinning of dislocations from pinning centers due to a change in the interaction forces between them. A drop in the electronic damping of dislocations during the transition into the superconducting state can also change the conditions for dislocation depinning. (auth)

13314 MAGNETOSTRICTION IN SUPERCONDUCTING INDIUM–LEAD ALLOYS. Braendli, G.; Enck, F. D.; Griessen, R. (Swiss Federal Inst. of Tech., Zurich). Helv. Phys. Acta; 44: No. 6, 784-93(1 Oct 1971).

The magnetostriction and the magnetization were measured in a series of indium alloys having a lead content ranging from 0 to 25 at. %. From the measured curves, of which some typical ones are presented, the critical temperature, T_c, the critical field at absolute zero, H_0, the coefficient of the electronic specific heat, γ, the Ginzburg–Landau parameter, κ, and in particular, their volume dependences are deduced. These parameters are related to variations in the crystal structure, the Fermi surface, and the mass-enhancement constant λ. (auth)

13315 SUPERCONDUCTIVITY OF Bi–Sn ALLOYS UNDER HIGH PRESSURE. Rabin'kin, A. G.; Laukhin, V. N. (Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 2, 642-55(Aug 1971). (In Russian).

A high pressure X phase is produced in Bi–Sn alloys at a pressure P = 30 kbar and T ≈ 360°K and in a broad concentration range (7.5 to 90 at.% Bi). The critical temperature T_c for alloys in such a structural state exceeds by two times T_c of pure tin, which is responsible for the superconducting properties prior to application of pressure. With increase of Bi content in the alloys, T_c increases monotonously but $\partial T_c/\partial P$ decreases. Removal of the pressure at 77°K after synthesis results in the metastable state remaining at P = 1 atm. The superconducting parameters of this state are higher than the initial values; thus T_c = 6.5 to 7.4°K and H_{c2} = 2.8 to 7.0 kOe on variation of the Bi content from 10 to 80 at.%, respectively. The data obtained pertaining to the superconducting properties of Bi–Sn alloys agree with the assumptions that the X phase in such alloys is a varying-composition phase based on Sn II and Bi VII modifications, and also that the X phase, Sn II and Bi VII all possess the same type of crystal lattice. If this is true then $T_c \to 7.5$°K for Sn II with P → 0, and $T_c(P)$ should be a nonlinear function. At P ≈ 30 kbar, $T_c = 8.2 \pm 0.3$°K for Bi VII. (auth)

13316 CRITICAL TEMPERATURE OF THE SUPERCONDUCTING STATE OF CERTAIN METALS OF THE SERIES Y–Pd. Korsunskii, M. I.; Genkin, Ya. E.; Zavodinskii, V. G. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 7, 1796-7(Jan 1972).

Translated from Fiz. Tverd. Tela; 13: No. 7, 2141-3(Jul 1971).

The critical temperature T_c is calculated using a model of transition metals, based on collective, locally bonding, and core electrons. Calculated interaction parameters γ and T_c are tabulated for Nb, Zr, Mo, and Ru, together with experimental values and results of Morel and Anderson (Phys. Rev. 125: 1263 (1962)). Good agreement with experiment is obtained. (D.L.C.)

13317 THEORY OF THE ABRIKOSOV VORTEX LATTICE IN SUPERCONDUCTORS WITH $\kappa \gg 1$. Rusinov, A. I.; Mkrtchyan, G. S. (Lebedev Inst. of Physics, Moscow. Inst. of Physical Research, Erevan). Zh. Eksp. Teor. Fiz.; 61: No. 2, 773-83 (Aug 1971). (In Russian).

A method is presented for calculating the lattice sums in superconductor vortex states for field strengths $H_{c1} \ll H_0 \ll H_{c2}$ and arbitrary lattices. It is shown that minimal energy is attained for a triangular lattice. The numerical coefficient in the logarithmic De Gennes induction law, the nuclear resonance line width, and vacancy formation energy in an Abrikosov lattice are calculated. It is shown that the thickness of a plate in a strong magnetic field parallel to the plate surface does not affect the nature of the vortex state. (auth)

13318 HELIUM CONSERVATION AND IT'S RELEVANCE TO FUTURE TECHNOLOGY. Laverick, Charles (Argonne National Lab., Ill.). pp 123-71 of Helium Society. /Blizin, Jerald (comp.). Washington, D. C.; Helium Society (1971).

From Helium society symposium; Washington, D. C. (3 May 1971).

The present and future demands for helium are discussed with criteria relative to population usage and industrial demands. Little helium has been conserved or saved, and a great amount is being lost in helium-containing natural gas being used as fuel. Typical uses of helium include rocket fuel pressurization, welding, cryogenics, balloons, leak detection, gas chromatography, diving, to name a few. Legislation involving helium is discussed and future governmental helium requirements are enumerated. Domestic and

foreign sources are discussed with the given recovery rates and costs. Large quantities of helium will be required before the end of the century for superconducting or cryogenic power transmission, new mammoth airships, and for magnetically levitated trains. Helium is a key component in the electrical power industry and in the development of atomic energy. High-temperature gas-cooled reactors and the liquid-metal-cooled fast breeder reactor will use helium. Superconducting magnet applications utilize helium and the prospects for higher-temperature superconductors are open, but until critical temperatures higher than boiling neon (27°K) are achieved, helium will be the favored cooling medium. Thermonuclear reactors may help helium production at some time since they may eventually produce about 1/4 of the helium needed. (J.C.W.)

13319 AC LOSSES IN SURFACES OF WEAKLY PINNED SUPERCONDUCTORS. Irie, F. (Kyushu Univ., Fukuoka); Ichikawa, H.; Yamafuji, K. pp 165-6 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The frequency and field dependences of low-field surface losses in weakly pinned superconductors are discussed both theoretically and experimentally. The specimen used for the experimental work was a 50/50 Nb–Ta rod. (auth)

13320 INVESTIGATIONS ON SUPERCONDUCTING Ti–Nb ALLOYS WITH ADDITIONS OF THIRD ELEMENTS. Loehberg, R. (Univ., Erlangen, Ger.); Heller, W.; Zwicker, U.; Oswald, B. pp 325-32 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The commercial application of a superconducting material for the construction of a superconducting magnet presumes that the superconductor carries a high current in an outer magnetic field. This property is influenced essentially by different inhomogeneities that may become normal-conducting in a magnetic field. Superconducting Ti–Nb alloys are proved in technical applications and magnets up to 100 kG are manufactured with this material. The addition of third elements may improve their superconducting properties. A short report is given on the influence of copper in Ti–Nb alloys on the inhomogeneities mentioned and on their superconducting properties. (auth)

13321 COMPOSITE FILAMENTARY SUPERCONDUCTORS. Adam, E.; Dosdat, J. P.; Blanc, J. M. (Thomson-CSF, Chatou, France). pp 333-8 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Composite filamentary superconductors are discussed and the correlation between structure, composition, co-drawingness, and critical current density given. Examples of realizations of fine filamentary composites and their characteristics are also presented. (auth)

13322 STUDIES ON SUPERCONDUCTING V_3Ga TAPES. Tachikawa, K. (National Research Inst. for Metals, Tokyo). pp 339-40 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

V_3Ga tapes produced by new diffusion processes can carry high lossless currents in a magnetic field of 200 kG. Procedures for making V_3Ga tapes and their superconducting properties and structures are described. (auth)

13323 STEADY-STATE STABILITY OF COMPOSITE SUPERCONDUCTORS WITH A COPPER-SOLDER STABILIZING SUBSTRATE. Schiller, A.; Rayroux, J. M.; Horvath, I. (Brown, Boveri and Co. Ltd., Zurich). pp 341-5 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The steady-state stability of various types of NbTi-composite superconductors, the substrates of which consist of copper or copper and solder, is investigated. To avoid magnetic instabilities, the bundle of superconducting strands imbedded in the stabilizing substrate is twisted. The steady-state performance of such conductors can be predicted by application of known theories that are adapted to a two-component substrate. A reliable prediction of the V–I characteristic requires physical data such as the thermal interface resistance between the superconductor and the substrate, the thermal conductivity of the superconducting strands, the heat flux from the substrate surface to the liquid helium, etc. Most of the data were measured for various NbTi-composite conductors, especially the thermal conductivities of cold-worked Nb–42%Ti and Nb–50%Ti wires (diameter 0.25 mm) as a function of the magnetic field. A method to determine the thermal interface resistance between the superconducting strands and the copper substrate is discussed. (auth)

13324 INVESTIGATIONS ON A TYPE-II SUPERCONDUCTOR. Van de Klundert, L. J. M. (Twente Univ. of Tech., Enschede, Netherlands); Alberga, G. E.; Van Der Marel, L. C.; Leijnse, C. pp 346-50 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Results of susceptibility experiments performed on a niobium cylinder after zone refining are discussed. The measurements were performed on a Hartshorn bridge in the frequency range of 25 to 3,500 Hz at different values of amplitude and temperatures from 1.3 to 4.2 K. (auth)

13325 SUPERCONDUCTORS AND DIRECT OBSERVATION OF THEIR MAGNETIC STRUCTURES. Obst, B. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). pp 466-72 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The magnetic behavior of Type-II superconductors is discussed. Experiments demonstrate that the crystal anisotropy may influence the symmetry of the flux-line lattice. In single crystals, e.g., with the four-fold symmetry axis parallel to the applied field, the flux lines may form a square lattice—in contrast to the triangular Abrikosov lattice. In ideal specimens the magnetization curve B(H) would be reversible. Experiments, however, always show a more-or-less pronounced hysteresis. This lack of uniqueness in the B–H relation is accompanied by deviations from the ideal structure of the flux-line lattice (vacancies and interstitials, flux lines, dislocations, disclinations, stacking faults, etc.). Some of these defects are discussed. (auth)

13326 FIELD DISTRIBUTION MEASUREMENTS BY THE MOLECULAR BEAM METHOD. King, J. G.; Brown, T. R. (Massachusetts Inst. of Tech., Cambridge). pp 33-41 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

The application of molecular beam magnetic resonance methods to the study of magnetic field distributions near the surface of superconductors is described. Details are given of the apparatus employed, and some results are given for vanadium. With regard to applications of the technique it is stated that, whenever any magnetic microstructure has a characteristic length between 3×10^{-4} and 3×10^{-6} cm, it can be studied by this method, using a variety of atoms in the beam, and time-varying magnetic phenomena can be measured in small regions. Ferromagnetic domains, motions of domain boundaries and phase transitions may also be studied—also magnetic variations arising from the de Haas–van Alphen effect—also periodic electric fields of the surfaces of a ferroelectric, using electric resonance with suitable molecules. (5 references) (UK)

13327 PHOTOLUMINESCENCE STUDIES OF SUPERCONDUCTING MATERIALS. Fraas, Lewis Martin. Los Angeles; Univ. of Southern California (1971). 211p. University Microfilms Order No. 72-549.

Thesis.

The frequency down-shifted light emitted from a metal surface when that surface is illuminated with focused laser light is studied. Small-frequency-shift gap structure in the photoluminescence spectra of superconductors is the main concern. Whereas earlier theoretical calculations have suggested gap structure at 2Δ in light scattering spectra, it is pointed out that gap structure should be observable at 4Δ, 6Δ, and 8Δ as well. Photoluminescence signals were observed experimentally. Experimental cross section measurements for various metals and evidence that the photoluminescence observed is characteristic of the band structure of metals are presented. In this connection, it is pointed out that the intensity of the small-frequency-shift photoluminescence is a measure of the resonant density of

states at an energy equal to the laser photon energy above or below the Fermi surface in a metal. Thus, by varying the laser frequency, it is possible to measure the resonant density of states in a metal and correlate that measurement with band structure. Such measurements were made for Cu and a peak is observed at 2.1 eV. Experimental measurements are presented of gap structure at 4Δ in the low-temperature photoluminescence spectra of NbN films. Gap structure in the low-temperature spectra of Nb_3Sn is also discussed. The experimental methods are discussed in some detail. In particular, various methods, of filtering off the elastically scattered laser light are discussed. In NbN, unexpected Raman phonon wing structure is found. This structure is attributed to nonstoichiometry and some corroborating experimental data from some samples of the cubic and hexagonal tungsten bronzes are presented. Gap structure at 4Δ and beyond will simplify the experimental situation considerably and also provide a method of improving understanding of optical processes in normal metals. (TSS) (Diss. Abstr. Int., B)

13328 FLUCTUATION-ENHANCED DIAMAGNETISM IN LAYERED SUPERCONDUCTORS. Yamaji, K. (Electrotechnical Lab., Tanashi, Japan). Phys. Lett.; 38A: No. 1, 43-4 (3 Jan 1972).

It is pointed out that the phenomenological theory well explains the temperature dependence of the fluctuation-enhanced diamagnetism in layered superconductors, which was observed by Geballe et al. (Phys. Rev. Lett., 27: 314(1971)) at temperatures up to 35°K. (auth)

13329 TRANSPORT ENTROPY AND TUNNELING BETWEEN VORTICES IN TYPE-I SUPERCONDUCTORS. De Lange, O. L.; Otter, F. A. Jr. (Clarkson Coll. of Tech., Potsdam, N. Y.). Phys. Lett.; 38A: No. 1, 13-14(3 Jan 1972).

The effect of tunneling between vortices on the vortex transport entropy in a Type-I superconductor is calculated and compared with experiment. Agreement is satisfactory in Sn + 0.05 at.% In, and in a 7500A Pb film. (auth)

13330 TEMPERATURES OF TRANSITION TO THE SUPERCONDUCTING STATE OF V_3Ge, V_3Al, AND SOLID SOLUTIONS OF $V_3Ge_xAl_{1-x}$ AND $V_3Ge_xGa_{1-x}$. Kodess, B. N.; Surikov, V. I.; Zagryazhskii, V. L.; Shtol'ts, A. K.; Gel'd, P. V. (Ural Polytechnical Inst., Sverdlovsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 5, 746-7(May 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 5, 853-4(May 1971).

The specimens were obtained by fusing vanadium (99.7%) with germanium, gallium, and aluminum (with less than 0.01% impurities) in an induction furnace in Al_2O_3 crucibles. The phase composition was established by x-ray and metallographic analysis. The chemical composition and the results of measurements of certain characteristics of the specimens are tabulated. Measurements of T_c were performed by the inductive method; the width of the transition was assessed by extrapolating the sector of maximal change in induction. (M.H.R.)

13331 STABILITY AND LOSSES IN HARD SUPERCONDUCTORS OF THE SECOND KIND. Pouillange, J. P.; Prost, G.; Rappanello, D. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 159, 17-23(May 1971). (In French).

The essential differences between superconductors of Type I and Type II are briefly reviewed. The critical current density is introduced in such a way as to outline the mechanisms involved in magnetic instabilities and electrical losses occurring in the variable magnetic field, which exists in these materials. Agreement between experiment and theory is satisfactory. (France)

13332 SUPERCONDUCTIVITY OF INDIUM FILMS WITH NETWORK STRUCTURE. Komnik, Yu. F.; Yatsuk, L. A.; Andrievskii, V. V.; Man'kovskii, K. K.; Pilipenko, V. V. (Physical-Technical Inst. of Low Temperature, Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 6, 1486-93(Dec 1971).

Translated from Fiz. Tverd. Tela; 13: No. 6, 1779-88(Jun 1971).

The structure, formation conditions, and superconducting properties of indium films having network structures have been studied. For a series of samples including continuous films and network structures with the same effective thickness but smoothly varying network parameters (the average cross section of a filament varied from 3.7×10^{-10} to 1.7×10^{-10} cm^2, and the average hole area from 9.6×10^{-9} to 1.2×10^{-9} cm^2), the change in the critical temperature T_c, the critical magnetic field $H_c^{\parallel}$ parallel to the film, and the change in the nature of the superconducting transition in a magnetic field perpendicular to the film was followed. The reasons for the observed regularities—the drop in T_c and $H_c^{\parallel}$, the rise in $H_c^{\perp}$, and the appearance of strong smearing of the transition in a perpendicular field—as a function of the fineness of the island structure are discussed. (auth)

13333 CRITICAL STATE IN HYSTERETIC LOW-κ TYPE-II SUPERCONDUCTORS. Pfeiffer, K.; Papp, R.; Weber, H. W. (Oesterreichische Hochschule, Vienna). Phys. Status Solidi (b); 46: No. 2, K77-80(1 Aug 1971).

The theory of Irie and Tamafuji (J. Phys. Soc. Japan, 23: 255(1967)) was applied to weakly hysteretic low-κ type-II superconductors. Calculations are in good agreement with an Nb–V experiment. (D.L.C.)

13334 SUPERCONDUCTIVITY AND SUPERCONDUCTING DEVICES. Mendelssohn, K. (Oxford Univ.). pp 261-91 of Advanced Cryogenics. /Bailey, C. A. (ed.). New York; Plenum Publishing Corp. (1971).

The history of superconductivity and the basic phenomena are dealt with first. Then some of the theoretical aspects are discussed particularly those which led to the concept of the Type-II superconductors. Finally the applications of superconductivity are discussed, concentrating mainly on the possible lines of approach and the physical background of what can and cannot be done and what looks more or less promising on the basis of physical phenomena. (M.H.R.)

Equipment and Devices

Refer also to abstracts 12156–12158, 13847–13849, 13856, 13899, and 13900.

13335 INDUSTRIAL PROMISE OF THE SUPER MOTOR. Appleton, A. (International Research and Development Ltd., Newcastle-upon-Tyne, Eng.). New Sci.; 52: No. 774, 157-9 (16 Dec 1971).

The world's largest superconducting motor, a 3250-hp dc machine, is a homopolar machine with a superconducting field winding providing nearly 3.10^6 ampere turns to give a maximum flux density of 3.7 tesla. The winding is maintained at 4.4 °K by liquid helium supplied by a closed-cycle refrigerator. The armature is at ambient temperature and is a segmented Faraday disc. Details of the manufacturers tests and subsequent trials when used to drive water cooling pumps at Fawley power station are given. These proved most successful in spite of difficulties with the helium compressor. Improved compressors are now available and units required for a marine propulsion system are being built. The advantages and possible design of an ac generator using superconductors are discussed. (UK)

13336 STABILISED SUPERCONDUCTOR ELECTRICAL CURRENT-CARRIERS. (to Siemens Aktiengesellschaft). British Patent 1,258,007. 22 Dec 1971. Priority date 4 Apr 1968, Germany.

The superconductor electric current carrier described contains an elongate load-current conductor consisting of a layer of superconductor material of Type I or II applied with negligible electrical contact resistance to a tubular stabilizing conductor formed of a metallic layer extending the length of the load-current conductor for taking up the current on overload. The stabilizing conductor consists of superconductor material of Type III, and the load-current conductor is formed as a tube coaxial with the stabilizing conductor. (M.H.R.)

13337 PROCEEDINGS OF THE THIRD INTERNATIONAL CRYOGENIC ENGINEERING CONFERENCE, BERLIN, 25–27 MAY 1970. Guildford, Eng.; Iliffe Science and Technology Publications Ltd. (1970). 510p. £14. (CONF-700522).

Eighty-eight papers are included on heat transfer, cryogenic cables, cryogenic current leads, research equipment, refrigeration, superconducting materials, superconducting magnets, cryopumping, cryogenic surgery, superconductivity, cooling below 1°K, insulation, and thermodynamic properties. A separate abstract was prepared for each of fifty-three papers. (M.H.R.)

For abstracts of individual papers see: 12155–12158, 12193, 13299, 13300, 13319–13325, 13338–13370, 13899–13902, 14336, and 14542.

13338 CHOICE OF CRYOGENIC CYCLES. Prast, G. (Philips Research Labs., Eindhoven, Netherlands). pp 21-4 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A general review of different refrigeration systems is given, including refrigeration by evaporation, Joule–Thomson systems, isentropic expansion cycles, and regenerative cycles. (M.H.R.)

13339 APPLICATIONS OF SUPERCONDUCTIVITY. Bogner, G. (Siemens AG, Erlangen, Ger.). pp 35-49 of Proceedings

of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Applications of superconductivity in electronics and high-frequency engineering are summarized, with particular reference to power engineering. (auth)

13340 ^{3}He: ITS PROPERTIES AND APPLICATIONS IN CRYOGENICS. Peshkov, V. P. (Inst. for Physical Problems, Moscow). pp 70-82 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

An extensive review is given of the properties and applications of helium 3, especially in regard to its uses in cryogenics. (auth)

13341 ^{3}He/^{4}He DILUTION REFRIGERATORS. Wiedemann, W. (Zentralinstitut fuer Tieftemperaturforschung, Garching, Ger.). pp 83-8 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The theoretical aspects and state of the art of helium-3–helium-4 dilution refrigerators are surveyed. (auth)

13342 PROBLEMS OF COOLING BELOW 1 mK. Kurti, N. (Oxford Univ.). pp 89-96 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The only method at present that seems at all hopeful for opening the temperature range below 1 mK is the nuclear cooling method, which relies on the adiabatic demagnetization of nuclear magnetic moments. The various aspects of energy or heat transfer in nuclear cooling are discussed and methods of measuring temperatures below 1 mK are outlined. While it is unlikely that the temperature range 1 μK to 1 mK will in the forseeable future become a working domain of the cryogenic engineer, this field poses many challenging problems to him, and their solutions may benefit other branches of cryogenics. (auth)

13343 RECENT ADVANCES IN HEAT TRANSFER TO HELIUM I. Johannes, C. (Centre d'Etudes Cryogeniques, Sassenage, France). pp 97-101 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Recent advances in the field of heat transfer with helium I are reviewed. The following modes of transfer are discussed in detail: boiling heat transfer under natural convection (pool boiling and boiling in confined channels), boiling heat transfer under forced convection (boiling in heated tubes), and heat transfer in the critical region. The most important aspects of each mode of transfer are discussed; the best correlations existing are presented; and the fields where further work is needed are indicated. (auth)

13344 DETERMINATION OF LINEAR AND CYCLIC IMPEDANCES OF AC CRYOCABLES. Deschamps, L. (Electricite de France, Clamart). pp 157-64 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Various specific problems, electrical and physical, raised by the use of pure metals in the normal state and of superconductors, in the design of cryogenic cables are studied. When subjected to very low temperatures, pure metals in the normal state, such as aluminum or beryllium, present a very shallow penetration depth that makes it necessary to subdivide the phase conductors into thin foils. Size effect is taken into account when determining the optimum thickness of such foils. The diagrams corresponding to coaxial-type cryogenic cables are first established, followed by a proposal to make these cables electrically symmetrical in a particular triple coaxial structure. With respect to trefoil superconductor cables, the important role played by the size, surface state, and internal structure of the superconductor material used is discussed; the equivalent electrical diagram is then drawn up. (auth)

13345 ALTERNATING TRANSPORT CURRENT LOSSES IN SUPERCONDUCTING WIRES. Eastham, A. R.; Rhodes, R. G. (Univ. of Warwick, Coventry, Eng.). pp 167-70 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A helium boil-off calorimeter was used to make alternating transport current-loss measurements on superconducting wires of different materials. The ac losses in various composite wires were also investigated. The results on Nb–44Ti with different thicknesses of Cu sheath clearly show the contribution to the loss from dissipative currents in the normal metal. The losses in filamentary composites, designed for stability under dc conditions, were also measured. Finally, the effect on the losses of twisting the filaments, and of increasing the resistivity of the matrix will be described. (auth)

13346 SUPERCONDUCTING MATERIALS FOR AC POWER CABLES. Brankin, P. R.; Linford, R. M. F.; Rhodes, R. G.; Seebold, R. J. A. (Univ. of Warwick, Coventry, Eng.). pp 171-5 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

To assess the relative suitability of superconducting materials for application in an ac power cable, loss measurements were made on short, cylindrical samples of Pb, Nb, and NbZr at 4.2 K. These were carried out in ac magnetic fields between 0 and 2×10^5 A/m (2,500 Oe) using an electronic wattmeter. The results show that when samples are cooled in the earth's field: (1) below the field of first penetration, H_{FP}, the losses are directly proportional to frequency, and strongly dependent on the surface finish of the samples; it is concluded that the losses result from hysteretic surface flux penetration; (2) above H_{FP}, the losses are strongly dependent on bulk flux-pinning and not on the surface finish; the losses in this region can be analysed in terms of a critical-state model. Improvement of the loss performance of Nb and Pb by enhancement of H_{FP} is discussed. (auth)

13347 ADIABATIC DEMAGNETIZATION OF RUBY AND SUPERCONDUCTING TUNNEL-JUNCTION THERMOMETRY. Bakker, J. W. M.; Van Kempen, H.; Wyder, P. (Katholieke Univ., Nijmegen, Netherlands). pp 217-19 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Tunnel junctions of superconducting and normal metal films were cooled to temperatures below 0.1 K by means of adiabatic demagnetization of a synthetic-ruby single crystal. The purpose of the experiments was to study the feasibility of a simple system for cooling superconducting films by means of adiabatic demagnetization of ruby and to check whether the tunnel-junction characteristics could be used below 1 K as a primary thermometer (assuming that the junction behaved according to the BCS theory). The films were deposited directly on to the ruby; also a calibrated Ge-thermometer was attached to the ruby. Low temperatures could be maintained sufficiently long to enable the tunnelling experiments to be performed. Both current (I) versus voltage (V), and dI/dV at V = 0 measurements were performed at different temperatures. From these measurements, using computer-generated I(V)-curves based on the BCS theory, the temperatures were determined; the calculated temperatures were compared with the temperatures indicated by the Ge-thermometer calibrated against the susceptibility of cerium magnesium nitrate. (auth)

13348 SUPERCONDUCTING MAGNET DEVICE FOR BIOLOGICAL RESEARCH. Blondet, R.; Rappanello, D.; Schneider, C. (CEN, Saclay, France). pp 238-43 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A superconducting magnet device and its cryogenic components are described. The magnet is used to give a magnetic field with a horizontal axis. This produces a Faraday effect which is used with a Roussel–Jouan dichrograph for the study of molecules and macromolecules having biological interest. (auth)

13349 DESIGN OF VALVELESS-TYPE PISTON EXPANDERS WITH VARIABLE CLEARANCE FOR A 1.5 W, 4.5 K HELIUM REFRIGERATOR. Leger, P.; Thomas, P.; Zermati, C. (Alcatel, Bruyeres-le-Chatel, France). pp 259-63 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A refrigerator without additional refrigeration and using two engines is being tested. This prototype, designed for a RMN spectrometer, is briefly described with some details on the principle (two-stage Claude cycle) and on the construction. The relative advantages of piston-type expanders with and without valves are briefly discussed and the properties of other expanders in relation to the potential applications are considered for the 1 to 3-W, 3.5 to 4.2 K helium refrigerator. Technical details are given on the two sizes of engines realized. Experimental results of the thermodynamic properties of the engines are given. The same engines operating in similar conditions with piston and cylinder made from the same material are compared. (auth)

13350 REFRIGERATION OF A SUPERCONDUCTING MAGNET FOR AN MHD GENERATOR. Kneuer, R.; Braeutigam, M. (Linde AG, Munich). pp 264-6 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A concrete application of a superconducting magnet for an MHD generator is discussed. The magnet has a mass of 1.4 tons and produces a homogeneous field of 40 kOe over a length of 1.4 m. It operates in a liquid-helium bath and requires during stationary operation a refrigeration power of 15W at 4.5K and 600W at 80K. (auth)

13351 LOW-TEMPERATURE COOLING SYSTEM FOR LARGE SUPERCONDUCTING MAGNET. Akashi, K. (Mitsubishi Electric Corp., Amagasaki, Japan); Ogino, O.; Daimon, K.; Todoriki, I. pp 267-70 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The development of two closed-cycle cooling systems as part of the research work for large superconducting magnets for MHD power generation is discussed. One is for a 2-ton, 75-kG pancake magnet, the other for a 12-ton, 45-kG saddle-shaped magnet. (auth)

13352 HELIUM REFRIGERATOR WITH CAPACITY OF 300 W AT 1.8 K. Sellmaier, A.; Glatthaar, R.; Kliem, E. (Linde AG, Munich). pp 310-14 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

To fulfill the demands of superconducting linear accelerators and particle separators a refrigerator has been designed with two oil-lubricated expansion turbines connected in series. The process of the plant of capacity 300 W at 1.8 K is described. The plant should be capable of acting as a liquefier or as a refrigerator. (auth)

13353 HEAT EXCHANGE IN DILUTION REFRIGERATORS. Roubeau, P. (CEN, Saclay, France); Le Fur, D.; Varoquaux, J.-A. pp 315-19 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The performance of various copper-foil heat exchangers mounted in dilution refrigerators is presented, and results of measurements of heat exchange at low temperatures are discussed. It is found that the Kapitza boundary resistance is not necessarily the limiting factor but that electron–phonon relaxation may play a dominant role. (auth)

13354 REFRIGERATION BY VORTEX MOTION IN SUPERFLUID HELIUM. Staas, F. A.; Severijns, A. P. (Philips Research Labs., Eindhoven, Netherlands). pp 320-4 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A new compact device for obtaining temperatures of about 0.7 K without using a large booster pump is described. The device makes use of the fundamental flow properties of superfluid helium and has quick operation, small dimensions, and no moving parts. (auth)

13355 SUPERCONDUCTING SADDLE-SHAPED MAGNET FOR A MHD GENERATOR. Koyama, K.; Ushio, K.; Todoriki, I.; (and others) (Electrotechnical Lab., Tokyo). pp 351-4 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A saddle-shaped magnet for an MHD generator was successfully constructed and economically cooled, using a refrigerator. The normal transition phenomena were studied, and the critical heat flux was found to be near the value of a model channel as long as the normal region of the magnet. (auth)

13356 LARGE SUPERCONDUCTING COILS FOR FUSION RESEARCH. Oswald, B. (Institut fuer Plasmaphysik, Garching, Ger.). pp 355-61 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Superconducting coils are presently feasible for plasma experiments if comparatively long operation times and large volumes of high fields, respectively, are required. For some types of experiments such as stellerators, linear field configurations, and MHD magnets, a technological and economic comparison between normal and superconducting magnets is given. Based on experience with various superconducting coils, large-module coils are being designed for the production of toroidal fields of 40 kG on the axis of a 4-m-diameter torus. Some other projects where the application of superconducting magnets seem to offer remarkable advantage are briefly described. However, if short-time operation up to pulse durations of some seconds is sufficient, simple and cheap (either in construction and operation) normal conductive magnets may be preferred. Some cryogenic but normal-conductive magnets, which are successfully operated or which are just under construction, are briefly characterized in order to give some specific comparative data with those of superconducting systems. In any case, a possible future fusion reactor necessitates superconducting coils if a tolerable efficiency is to be achieved. The specific problems involved in high-field and extremely large superconducting coil systems, necessary for this application, are described. (auth)

13357 SUPERCONDUCTING SOLENOID FOR 0- TO 50-kOe MAGNETIC FIELD. Kirschner, I.; Papp, E.; Kovacs, I.; Fricsovszky, Gy. (Eoetvoes Lorand Univ., Budapest). pp 362-3 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A superconducting solenoid of cylindrical geometry is discussed. The solenoid is to be used for investigations into the electric, magnetic, and surface-superconductivity phenomena of Type-II superconductors. (auth)

13358 45-kG SADDLE-SHAPED SUPERCONDUCTING MAGNET. Kimura, H.; Doi, T.; Sato, S.; Kasahara, T.; Iizuka, T. (Hitachi Ltd., Tokyo). pp 364-8 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Design criteria and operating characteristics of the superconducting magnet, the persistent switch, and the cryostat of a large saddle-shaped superconducting magnet are described. The magnet was successfully tested and a maximum central field of 47 kG attained without quenching in the winding. Field uniformity was 95% for effective space and the persistent-mode decay constant more than 1,330 hr. (auth)

13359 VERY SMALL MAGNETS OF SINGLE-CORE SUPERCONDUCTOR MATERIAL UNDER STATIC AND DYNAMIC STRESSING. Best, K. J. (Vacuumschmelze GmbH, Hanau, Ger.). pp 369-73 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Very small magnets wound with Nb–Zr 25 and Nb–Ti 50 single-core inductor material (inductivities in the range from 0.3 to 14 mH) were tested in their own and foreign fields. Experiments at a low dB/dt show extensive agreement between the results obtained on these specimen coils and larger magnets. With a high dB/dt, there are great differences in the behavior of the individual small magnets. The attainable critical current intensity under dynamic stressing of the individual specimen coils is, among other things, critically dependent on their dimensioning. (auth)

13360 CONDENSATION AND EVAPORATION OF HYDROGEN ON LIQUID-HELIUM-COOLED SURFACES. Lee, T. J. (Royal Observatory, Edinburgh. United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 388-92 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Experimental data on the condensation of hydrogen on surfaces cooled below 3 K have been of interest to scientists and engineers evaluating cryopumping systems for plasma and high-energy physics experiments. Recent developments in the physics of the formation of stars and galaxies provide added interest in the factors affecting the gas density of hydrogen in equilibrium with films of solid hydrogen at low temperatures. Previous studies of the cryopumping of hydrogen show departures from the expected saturated vapour pressure curve at gas densities below about 10^9 molecules cm^{-3}($\sim 10^{-9}$ torr). Available experimental data indicate that the departures from the expected curve may result from thermal radiation incident on the surface and from the nature of the surface. In order to investigate the physics of these anomalies, studies were carried out in a cryopump in which the thermal radiation loading was reduced to below 10^{-4} W/cm^2. Background gas densities, sticking coefficients and desorption rates are measured at constant substrate temperature under a variety of conditions specified by the incident gas temperature, gas composition and thermal radiation loading. Isosteres are obtained in the range 4 to 1.7°K under conditions specified by the thermal radiation loading, quantity of hydrogen, gas composition and nature of the substrate. (auth)

13361 INVESTIGATIONS ON A SUPERCONDUCTING SHIELDING CONTAINER WITH AN ENCLOSED COIL. Dietrich, I.; Maier, R. G.; Weyl, R.; Zerbst, H. (Siemens AG, Munich. Siemens AG, Erlangen, Ger.). pp 422-5 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

To avoid stray fields caused by magnetic coils, superconducting containers made from a material with high current-carrying capacity are useful. If shielding of relatively high fields is required, a superconducting device is preferred to a ferromagnetic one. Superconducting shielding was effectively applied in a cryogenic electron microscope lens. The shielding container was made of niobium stannide sintered at 1,000°C and consisted of a hollow cylinder closed by two discs. Leaks of the field into the space outside the shielding occurred only when cracks developed in the container material. The field distribution changed considerably, compared to that of open coils. This was proved by field measurements with Hall probes. The experimental results were confirmed by numerical calculations. (auth)

13362 DESIGN OF A LARGE INTEGRATED SUPERCONDUCTING MAGNET SYSTEM. Eatwell, A. J.; Goodman, B. B.; Instone, C. S.; Jones, J. E.; Lanning, J. R. (BOC Research Centre, London). pp 426-32 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Design for a complete system, incorporating a superconducting magnet and a closed-cycle helium refrigerator, is presented. The magnet, situated in an annular cryostat surrounded by a soft iron yoke, is designed to produce a uniform axial field of 2.0 T in a cylindrical volume 1.4 m in diameter and 1.1 m long; over about 75% of this volume the field is uniform to within ±5%. The magnetic stored energy with the yoke in place is 3.9 MJ. (auth)

13363 PROBLEMS RELATED TO THE DESIGN OF A TURBO-ALTERNATOR WITH SUPERCONDUCTING FIELD WINDING. Sabrie, J. L. (Electricite de France, Clamart). pp 433-7 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A 600-MW turbo-alternator with superconducting rotating field winding is studied. A study of the thermal, mechanical, and electromagnetic problems that this type of equipment entails leads to a definition of the general structure of the machine. Starting from this basic configuration, it is shown that the thermal losses brought to room temperature are lower than the excitation losses of a traditional turbo-alternator of the same power. Moreover, it is shown that the use of a magnetic steel in the manufacture of the rotor, when necessary, is made possibly by the performances of available superconductors. The latter may be protected from any influence from the alternating magnetic field at the cost of a few extra losses. Finally, a general study attempts to point out some of the interesting characteristics of this turbo-alternator, particularly its dimensions, its efficiency, and certain electrical characteristics. (auth)

13364 PROBLEMS ASSOCIATED WITH THE MANUFACTURE OF INDUSTRIAL SUPERCONDUCTING RECTIFIERS. Ferrier, M. (Electricite de France, Clamart). pp 438-42 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

In the past, several superconducting rectifiers have been available, but because of their low power they have been designed for use only as laboratory auxiliaries; the technological problems associated with the manufacture of high-power rectifiers are examined. After a review of the operating principle, the basic processes and the corresponding losses are enumerated; the losses are formulated in terms of the inverse current; the value of the losses from magnetic hysteresis is calculated, the existence of further dissipation resulting from lack of instantaneity in the transition at the moment of commutation is indicated. From this, the laws defining the structural characteristics and the performances required of the materials to be used are deduced. The thermal problems and their influence on the design of the structure of the conducting, insulating, and cooling media are cited. For most of these points, the results of experimental simulations are given. Finally, the energy problems related to the control of a converting station are made the object of a critical study leading to some original solutions of which the coefficients of performance are compared. (auth)

13365 PERFORMANCE OF A LARGE SUPERCONDUCTING MOTOR. Appleton, A. D.; MacNab, R. B. (International Research and Development Co. Ltd., Newcastle-upon-Tyne, Eng.). pp 443-6 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A 2.5-MW motor has recently been built and tested at International Research and Development Company Limited. This motor is of the homopolar type and has a superconducting field coil of 2.8-m diameter giving a maximum flux density of 3.7 T. In laboratory tests it has been possible to load the motor only to 20% of its full-load capability, although the superconducting coil has already operated at its full field. The motor will shortly be installed in a power station where it will operate at full load, driving a main cooling-water pump. An outline is provided of the machine design, and economic as well as technical factors discussed. All available details are presented on machine performance in the laboratory and on-site. Significant advances in design and materials are mentioned, and the performance of future machines is described. Applications and commercial prospects for this type of machine are discussed, both for motors and for generators operating on the same principles and using superconductors. Comparisons are made between conventional and superconducting machines. (auth)

13366 DIAMAGNETIC BEHAVIOUR OF COILS WOUND FROM MULTIFILAMENT STABILISED SUPERCONDUCTORS. Clee, P. T. M.; Gottfeldt, P.; Thomas, D. B.; Trowbridge, C. W. (Rutherford High Energy Lab., Didcot, Eng.). pp 450-5 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The use in coils of composite conductors with parallel superconducting filaments leads to the formation of magnetization current loops in the conductor, which decay very slowly. Associated magnetic field distortions amounting to several percent of the central field value are then likely to occur. These difficulties can be avoided with twisted-filament composites. Experiments with coils using both parallel and twisted-filament conductor are described. A large discrepancy between the measured decay rates of the magnetization currents and the predictions of a simple magnetic diffusion equation is partially explained. (auth)

13367 DESIGN AND PROPERTIES OF INTRINSICALLY STABLE MULTISTRAND SUPERCONDUCTORS. Hillmann, H. (Vacuumschmelze GmbH, Hanau, Ger.). pp 456-60 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The theoretical aspects of intrinsically stable multistrand superconductors are discussed, and results of experiments with untwisted filament composites are presented. Twisted high-current composites are also discussed, particularly with respect to their stability. (auth)

13368 ENERGY LOSSES AND INSTABILITIES OF SUPERCONDUCTING MULTIFILAMENT COMPOSITE CONDUCTORS CAUSED BY INTERFILAMENT MAGNETIZATION CURRENTS. Kwasnitza, K.; Horvath, I. (Brown, Boveri and Co. Ltd., Zurich). pp 461-5 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

It has been predicted that in composite superconducting wires, which consist of many superconducting filaments in a matrix of normal conducting metal, a large increase of magnetization would be caused by shielding currents that flow from filament to filament through the normal conducting metal and that these transverse currents occupy a finite length of conductor l_c. It is suggested that twisting or transposing the wires with a pitch $l < l_c$ should reduce this type of magnetization. Magnetization measurements were made on NbTi superconducting composite wires exposed to a magnetic field sweep $\dot{H}$. The influences of twisting of the wires on (a) magnetization, (b) energy losses, and (c) flux jumps are investigated. The l_c is measured and compared with the value predicted by theory. The decay time of the transverse magnetization currents is experimentally determined. (auth)

13369 NUCLEAR COOLING COMBINED WITH DILUTION REFRIGERATION. Berglund, P. M.; Ehnholm, G. J.; Gylling, R. G.; Lounasmaa, O. V.; Sovik, R. P. (Technical Univ. of Helsinki, Otaniemi, Finland). pp 473-7 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A cryostat is described in which dilution refrigeration and nuclear cooling operate in series. Preliminary experiments have resulted in an equilibrium temperature of 0.62 mK in the copper nuclear stage. This is the lowest lattice and conduction electron temperature ever achieved. The nuclear stage remained below 1 mK for more than 4 hr. (auth)

13370 COMPARATIVE PERFORMANCES AND BEHAVIOUR OF SEVERAL DIFFERENT TYPES OF DILUTION REFRIGERATOR. Phillips, D.; Woodgate, J. M.; McKinnon, J. B. (Oxford Instrument Co. Ltd.). pp 478-81 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

Performance of six different types of dilution units that have been tried in combination are compared to three different helium-3 circulating systems in dilution refrigerators. The dilution units include a simple tubular heat exchanger, together with some modified versions of this unit, a modular sintered-metal heat exchanger and hybrid heat exchangers that combine the advantages of both these types. The pumping systems are based on a 2-inch mercury booster diffusion pump that can be backed cryogenically and on 4- and 9-inch oil diffusion pumps backed by sealed rotary pumps of appropriate pumping capacities. The advantages and disadvantages of each system are indicated. Results are presented to illustrate the comparative refrigerating capacities of the various refrigerators, and comments made about the general behavioral properties of the various systems. Various sources of heat leaks that can be detrimental to successful operation of dilution refrigerators are analyzed, and some of the techniques used to eliminate them are given. (auth)

13371 CYCLING CASCADE ^{3}He–^{4}He REFRIGERATOR. Pennings, N. H.; Taconis, K. W.; de Bruyn Ouboter, R. (Rijksuniversiteit, Leiden). Physica; 56: No. 1, 171-2(15 Nov 1971).

A new type of cycling ^{3}He–^{4}He refrigerator was developed in which cooling takes place due to dilution of ^{3}He in an assembly of several dilution chambers connected in series by capillaries. During each cycle the temperature range from 0.25 K down to 30 mK can be covered. At the lowest temperature the rate of temperature rise is about 1 mK per 5 min, whereas the duration of a full cycle is about 20 min. (auth)

13372 ^{4}He–^{3}He REFRIGERATOR THROUGH WHICH ^{4}He IS CIRCULATED. Taconis, K. W.; Pennings, N. H.; Das, P.; de Bruyn Ouboter, R. (Rijksuniversiteit, Leiden). Physica; 56: No. 1, 168-70(15 Nov 1971).

An alternative ^{4}He–^{3}He refrigerator was developed in which ^{4}He is circulated instead of ^{3}He. A short description of the refrigerator is given, followed by some results obtained. (auth)

13373 SUPERCONDUCTING ELECTRICAL MACHINES. Mulhall, B. E. (International Research and Development Co., Newcastle upon Tyne, Eng.). Phys. Bull. (London); 22: 721-4(Dec 1971).

The development of superconductors has now reached the state where it is possible to engineer compact windings to generate magnetic field intensities several times those attainable with steel yokes and poles, even despite the cost and complexity of refrigeration at liquid helium temperatures. This technology has made possible the revival of the homopolar principle and the consequent developments in large dc machines, and also promises to revolutionize the design of large ac power generators. Though detailed technical problems remain, the exploitation of these machines is now largely a matter of economics and the industrial acceptance of these novel technologies. (UK)

13374 SENSITIVITY OF THE Q OF SUPERCONDUCTING rf CAVITIES TO SURFACE CONDITIONS. Strongin, Myron (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys.; 42: No. 10, 4105-7(Sep 1971).

Why presumably delicate changes in the surface can affect the cavity Q is discussed. It is thought that there is a more fundamental question than is discussed in previous explanations such as dielectric losses and normal nucleation sites at imperfections. The main point made is that, while in tunneling measurements the electrons moving normal to the surface are important, for microwave measurements at a long mean free path and at $f \sim 10$ GHz, these electrons are unimportant and the electrons traveling nearly parallel to the surface are more important. This means that the microwave electrons traveling in a low-T_c surface layer will not experience the gap of the massive metal underneath as much as in the tunneling case. (M.H.R.)

13375 ADVANCED CRYOGENICS. Bailey, C. A. (ed.). International Cryogenics Monograph Series. New York; Plenum Publishing Corporation (1971). 535p. $25.00.

Twenty chapters are included; separate abstracts were prepared for four. Two previously appeared as NSA 25: 43327 and 25: 42137. (M.H.R.)

For abstracts of individual chapters see: 13334, 13376, 13377, and 13917.

13376 MEASUREMENT OF LOW TEMPERATURES. Berman, R. (University Coll., Oxford). pp 103-32 of Advanced Cryogenics. /Bailey, C. A. (ed.). New York; Plenum Publishing Corp. (1971).

A temperature measured on the thermodynamic scale according to a method described is independent of the thermometric substance used. In practice, determinations of thermodynamic temperature are made by measurements of a different kind on gases at relatively low pressures. Neither pyrometry nor magnetic thermometry is discussed. Work done on the temperature dependence of the electrical resistance of pure platinum is described. Fixed points and vapor pressure are discussed. Other more exotic electrical resistance thermometers are mentioned. (M.H.R.)

13377 SUPERCONDUCTIVE MAGNETS. Wood, M. F. (Oxford Univ.). pp 293-315 of Advanced Cryogenics. /Bailey, C. A. (ed.). New York; Plenum Publishing Corp. (1971).

The following topics are covered: the place of superconducting magnets, magnet design, practical materials and cryogenic considerations. (M.H.R.)

Radiation Physics and Shielding

Refer also to abstract 14481.

Radiation Physics

Refer also to abstracts 13137, 13155, 13930, and 13935.

13378 (BNL-tr-462) EFFECT OF MULTIPLE SCATTERING ON THE 250 TO 600-MeV ELECTRON RADIATION IN LAMINAR MEDIA. Arutyunyan, F. R. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Dokl. Akad. Nauk Arm. SSR; 48: No. 1, 32-5(1969). 8p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 12627.

13379 EXTRAPOLATION DISTANCE CALCULATIONS. Su, S. F.; McCormick, N. J. (Univ. of Washington, Seattle). J. Nucl. Energy; 25: No. 12, 657-8(Dec 1971).

The procedure of Pahor (1966) is used to calculate extrapolation distances for one-group transport with anisotropic scattering. Results for a scattering model agree with those from the method of van de Hulst (1968). (auth)

13380 Z DEPENDENCE OF LINEAR POLARIZATION IN ELASTIC SCATTERING. Molak, B.; Ilakovac, K.; Ljubicic, A. (Inst. Ruder Boskovic, Zagreb). Fizika (Zagreb); 3: No. 4, 239-46(Oct 1971).

A new method for measuring linear polarization was applied to study the Z dependence of the degree of linear polarization in the elastic scattering of 662-keV gamma rays at 90°. The measurements were performed with five elements: Sn, Sm, Hf, Pb and U. The degree of polarization decreases with increasing Z. The calibration of the efficiency of the polarization analyzer was made by measuring the asymmetry ratio of Compton-scattered gamma rays in graphite. (auth)

13381 GAMMA-RAY ALBEDO CALCULATIONS USING MOMENTS METHOD. Smith, C. V. (Naval Ship Research and Development Center, Washington, D. C.); Scofield, N. E. Nucl. Sci. Eng.; 47: No. 1, 1-7(Jan 1972).

The results of a gamma-ray backscattering calculation using the moments method are shown. Results are shown for the differential angular energy distribution of gamma-ray flux backscattered from semi-infinite media of aluminum and iron. A plane normal source of 0.66-MeV gamma rays from ^{137}Cs is simulated in the calculation. A comparison is shown between the calculated albedo spectra and results from an experiment. The calculated albedo distributions were slightly higher in the multiple scattering peak area for angles greater than 130°; otherwise, the comparisons were very good. The slight discrepancies can be explained by the finite slab boundary effects from the experiment. (auth)

13382 TRANSFER OF ENERGY FROM ALPHA PARTICLES TO THIN TISSUE EQUIVALENT LAYERS. Booz, J. (Joint Nuclear Research Center, Ispra, Italy). pp 119-22 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In German).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Measurements are presented on the differential average energy absorbed per ion pair created, W_α, from α particles. The results were obtained by comparing the linear ion density with the mass stopping power. A proportional counter filled with a tissue-equivalent gas mixture was used. The thickness of the sensitive tissue layer is defined by the distance between the guard electrodes and the gas pressure. It could be varied between 50 Å and 1 micron. All the delta rays were absorbed by the counter because of its large diameter (30 cm). Moderators were used to vary the energy of the α particles (0.3 to 4.5 MeV). Between 4 and 5 MeV, the differential average energy per ion pair, W_α, is within the range of error equal to the W value of the γ rays. For lower α energies, W_α increases. (France)

13383 METHOD OF MEASURING THE TOTAL MASS ATTENUATION COEFFICIENT FOR X-RAYS WITH ENERGIES BETWEEN 20 AND 90 keV. Panzer, W.; Perzl, F. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). pp 127-31 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In German).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

Methods of measuring the total mass attenuation coefficient are presented, and the experimental equipment used is described. The values and graphical representations of the total mass attenuation coefficients for Cu, Ge and Si, and two other substances, CEC and LiF, used in dosimetry in the 20- to 90-keV energy range, are given. (France)

13384 ENERGY LOSSES BY ELECTRONS IN MATTER. METHOD OF CALCULATION AND RESULTS. Bertel, E.; Joffre, H.; Pages, L.; Sklavenitis, L. (CEN de Saclay, Gif-sur-Yvette, France). pp 159-71 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France; Service Central de Protection Contre les Rayonnements Ionisants (1971). (In French).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

In order to determine the stopping power, the energy losses by ionization and bremsstrahlung were separately calculated. Energy losses due to ionization were determined, using the slowing-down theory of Bethe. In order to take density effects into account the normally used empirical relations developed from the basic functions established by Fermi were not considered. Energy losses due to bremsstrahlung were calculated from formulas proposed by Koch and Motz. A computer program was developed and written in Fortran IV for an IBM 360-75 machine. This program permits the calculation of stopping powers, free paths, and electron bremsstrahlung yields for energies between 10 keV and 100 MeV for all the elements likely to be used in tissue-equivalent materials, and also for certain tissue-equivalent mixtures. (France)

13385 CHARGE ACCUMULATION IN A PLATE OF RADIOACTIVE MATERIAL. Vorob'ev, A. A.; Evdokimov, O. B. (Tomsk Polytechnical Inst., USSR). High Energy Chem. (Engl. Transl.); 4: No. 4, 311-12(Jul-Aug 1970).

Translated from Khim. Vys. Energ.; 4: No. 4, 356-7(MJul-Aug 1970).

The kinetics of charge accumulation in a conducting, insulated plate of radioactive material in a gaseous medium are examined. Two cases are considered: (1) where the effect of diffusion and drift of the charge carriers on their distribution in the surrounding medium can be neglected, and (2) where drift plays an essential role. (M.H.R.)

13386 CALCULATION OF THE K X-RAY INTENSITIES FOR ELEMENTS FROM Z = 92 TO 126. Lu, C. C.; Malik, F. B.; Carlson, Thomas A. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A175: No. 2, 289-99(1971).

Calculations of the radiative transition rates are made for filling a K-shell vacancy from electrons in the L, M, N, O, and P shells for each element from Z = 92 to 126. With the help of these values and the previously calculated x-ray energies, one may use x-ray spectra arising from K vacancies of the heavy and superheavy elements as an unambiguous means for identifying these elements. The calculations are relativistic, and utilize relativistic Hartree–Fock–Slater wave functions. From the radiation rates the natural widths are also computed, and a listing of binding energies and x-ray energies is given for elements Z = 121 to 126. (auth)

13387 RANGE CHARACTERISTICS OF PHOTOFISSION FRAGMENTS OF URANIUM, BISMUTH, GOLD, AND TANTALUM. Kasilov, V. I.; Mitrofanova, A. V.; Ranyuk, Yu. N.; Sorokin, P. V. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: 489-91(Mar 1971). (In Russian).

The range distributions of fragments in air and in lavsan from photofission of ^{238}U, Bi, Au, and Ta were measured. The average paths of fragments in lavsan were 17.8 and 14.0 μ for light and heavy U fragments, 14.2 μ for Bi, 11.2 μ for Au, and 10.3 μ for Ta. Mean paths for air were 24.5 and 20.3 mm for U, 18.3 mm for Bi, 16.5 mm for Au. (K.S.W.)

13388 USE OF RESONANT NUCLEAR REACTIONS TO MEASURE THE SLOWING-DOWN AND STRAGGLING OF PROTONS. Chemin, R.; Roturier, J.; Petit, G. Y. (Bordeaux Univ., Gradignan, France. J. Phys. (Paris); 32: No. 4, 219-23(Apr 1971). (In French).

A simple method allowing the determination of energy loss and straggling of 1–4 MeV protons is presented. Nuclear resonant reactions are used. The data concerning the straggling were compared to theoretical work from Bohr, Symon, Vavilov and Tschalar. From this comparison a phenomenological expression of the straggling was deduced. (France)

Shielding

Refer also to abstracts 13842, 13923, and 13927.

13389 (CONF-710402-(Vol.1), pp I.65-84) RECENT DEVELOPMENTS IN THE SHIELDING OF NEUTRON SOURCES. Claiborne, H. Clyde (Oak Ridge National Lab., Tenn.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

This paper on recent developments in the shielding of neutron sources is basically composed of two parts. In the first part, the impact of ^{252}Cf on shielding of neutron sources is discussed, the newer methods used for coupled neutron–gamma-ray shielding calculations and shield weight optimization are reviewed, and some shipping cask designs for ^{252}Cf and other transplutonium elements are discussed. The second part consists of a summary

and discussion of the six papers on neutron source shielding that were contributed to the American Nuclear Society Topical Meeting on Neutron Sources and Applications at Augusta, Ga., 1971. Two papers are about the attenuation properties of various materials for the neutrons from ^{252}Cf and other neutron sources; one compares measurements and calculations for ten different shielded containers for ^{252}Cf; two involve the design of portable neutron source facilities; and one the use of tissue-equivalent proportional counters. (auth)

13390 ELECTRON DEPTH-DOSE DISTRIBUTION MEASUREMENTS IN POLYSTYRENE. Rosenstein, Marvin. College Park; Univ. of Maryland (1971). 107p. University Microfilms Order No. 72-1646.

Thesis.

Experimental depth-dose curves for 2.00-MeV electrons incident on slabs of polystyrene were obtained for broad beam geometry for various slab thicknesses and incident beam angles. Calibrated radiochromic dye films were used as dosimeters. The films were positioned diagonally in the slabs. The continuous spatial absorbance changes in the irradiated films were recorded with the aid of a specially constructed scanning densitometer and converted into local absorbed doses. Electron fluence incident on the surface of the polystyrene slabs was determined by charge collection measurement. These two measurements permitted direct determination of energy deposition per unit electron fluence in polystyrene as a function of depth. (TSS) (Diss. Abstr. Int., B)

13391 ELECTRONS SCATTERED FROM SUPERVOLTAGE PHOTON BEAMS. Purser, P. R. (Mt. Zion Hospital, San Francisco). Phys. Med. Biol.; 16: No. 4, 700-1(Oct 1971).

Measurements made on an 8-MeV linear accelerator showed that for a 20 × 20 cm field, the dose inside the beam edge was 50% on the surface, rising to 100% at the equilibrium depth of 1.8 cm. At 5 cm outside the beam edge, the surface dose was 15%, falling to a minimum of 3% at the equilibrium depth. The surface dose outside the beam edge was presumed due to electrons generated in the collimator and irradiated air column and could have significance in shielding during radiotherapy. (UK)

13392 DIAPHRAGM FOR LIMITING BEAM OF IONIZING RADIATION. Atovmian, Artashes Ervandovich; Gordon, Vladimir Iosofovich; Davydova, Irina Alexeevna; Litvan, Abram Bentsionovich; Mazanko, Boris Pavlovich British Patent 1,258,028. 22 Dec 1971. Filed 16 May 1970.

The component described is intended mainly for use in medical radiology, but can find other applications. It comprises a housing accommodating at least two pairs of blocks made of radiation shielding material and defining a beam outlet hole. All of the blocks are displaceable in a direction laterally disposed with respect to the direction of the beam in order to adjust the size of the hole. Several different block arrangement geometries are described. The system is stated to be less complicated and more compact than most other systems in use. (UK)

Solid-State Physics

Refer also to abstracts 12815, 14075, and 14081.

Radiation Effects

Refer also to abstracts 11532, 12711, 12812, and 13131.

13393 (CEA-CONF-1886) POINT DEFECTS IN REFRACTORY METALS: NIOBIUM, MOLYBDENUM, TITANIUM, AND ZIRCONIUM. Pichon, R.; Moser, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires); Moser, P. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). [1970]. 16p. (CONF-710905-3). Dep. NTIS (U. S. Sales Only).

From International conference on defects in refractory metals; Mol, Belgium (20 Sep 1971).

Internal friction was used to detect and study the behavior of interstitials produced by irradiation in bcc and hcp metals. Simultaneous measurements of electric conductivity and dynamic modulus were also made to clarify the internal friction results. The metals studied included Nb, Mo, Ti, and Zr. The results for Nb showed an impurity-dependent substage at 215°K, which was interpreted by release of interstitials from oxygen traps. There was also evidence that oxygen was trapped by defects induced by neutron irradiation between 410 and 460°K, which was the temperature of stage III electric recovery. In contract to Nb, annealing steps in Mo were similar to fcc metals, which showed a low-temperature Stage I, a continuous Stage II, and a high-temperature Stage III recovery. Neutron irradiation induced a dynamic modulus change in α-Zr and α-Ti due to an elastic effect. (P.C.H.)

13394 (TID-25828) EFFECT OF 1.5 MeV ELECTRON IRRADIATION ON THE TRANSMISSION OF OPTICAL MATERIALS. Palma, Gary E.; Gagosz, Ronald M. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Sep 1971. Contract SNPC-70. 49p. (K-990929-2). Dep. NTIS.

A program of experiments was conducted to measure the optical transmission of several transparent materials before, during, and immediately after 1.5-MeV electron irradiation. These experiments were conducted using a Dynamitron electron accelerator as a source of 1.5-MeV electrons. A preliminary experiment was also conducted to evaluate the feasibility of using the Langley pulsed LINAC electron accelerator as a source of higher-energy electrons (3 to 10 MeV) in future experiments. The Dynamitron experiments included a comparison of irradiation-induced optical absorption in three commercial grades of high-purity fused silica. It was found that the behavior of Corning 7940, Amersil, and Spectrosil high-purity grades of fused silica were similar with regard to the generation, annealing, and optical bleaching of the irradiation-induced optical absorption in the wavelength interval 2000 to 3000 Å. In addition, measurements of the optical transmission of single-crystal specimens of aluminum oxide, magnesium fluoride, barium fluoride, lithium fluoride, and beryllium oxide were made during 1.5-MeV electron irradiation in the wavelength interval 2000 to 3000 Å. (auth)

13395 F-CENTER PRODUCTION EFFICIENCY IN NaCl IRRADIATED WITH ELECTRONS. Porreca, Flavio (Univ., Naples. Gruppo Nazionale Struttura della Materia, Naples). Solid State Commun.; 9: No. 23, 2105-9(1 Dec 1971).

The irradiation of NaCl crystals with electrons of a few-MeV energy, when the crystals are thicker than the electron range, produces F-bands, the absorption of which is not constant with the depth. Taking into account the inhomogeneity of the F-center density, the first results of the mean efficiency of the F-center production with 0.25, 1.25, and 2.25-MeV electrons are given, which fit very well in Ritz's summary of the efficiency measurements. (auth)

13396 INVESTIGATION OF RADIATION PRODUCTION AND THERMAL DESTRUCTION OF COLLOIDAL COLOR CENTERS IN NaCl CRYSTALS. Kristapson, Ya. Zh.; Kalimulin, S. S. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 5, 14-19(1971). (In Russian).

The absorption spectra of natural and synthetic NaCl crystals were investigated after 3.5-MeV electron irradiation (to doses 3500 Mrad) and subsequent heating. Colloidal X centers were formed in those crystals if sufficiently large numbers of F centers were produced. The consolidation of colloidal centers was observed in large-dose irradiated crystals. In the natural crystal, the X centers were best produced at 435°K, ~50°K more than in synthetic crystals. The heating of crystals showed more thermal stability of the X centers in the natural crystal, which has large dislocation concentration. The colloidal centers were generated at 300 to 380°K in NaCl easier than in KCl crystals. The result is accounted for by the fact that the most effective F-center generation occurs in NaCl in the room-temperature. (auth)

13397 NO EXPERIMENTAL EVIDENCE FOR A CHANNELING EFFECT IN THE LIGHT EMISSION FROM ION BEAMS EXCITED BY GOLD CRYSTALS. Poizat, J.-C.; Remillieux, J.; Desesquelles, J. (Univ. Claude Bernard, Lyon). Phys. Lett.; 37A: No. 5, 427-8(20 Dec 1971).

The light emission of a 600-keV He^+ beam excited by 300- to 600-Å thick gold crystals was measured. For the three studied spectral lines in He^+, no influence of channeling was seen. (auth)

13398 ATOMIC DISPLACEMENT BY FAST NEUTRONS. Ohmae, K.; Hida, B. (Hitachi Ltd., Japan). J. Nucl. Mater.; 42: No. 1, 86-90(Jan 1972).

An attempt is made to improve the Kinchin–Pease atomic displacement model for fast-neutron bombardment, taking the effect of the displacement threshold energy into account. It is found that the modified displacement model (MDM) yields relatively simple analytic expressions for the total number of atomic displacements produced by fast neutrons. Application of this model to the relative vacancy production rate in iron exposed to various fast-neutron spectra was suggested. A sample calculation indicated that the treatment gives a vacancy production rate for iron about 20% lower than that advanced by Kinchin and Pease, and modified by Kelly. (auth)

13399 HELIUM RELEASE AND ELECTRON-MICROSCOPY OF HELIUM-IMPLANTED PALLADIUM. Bauer, W. (Sandia Labs., Livermore, Calif.); Thomas, G. J. Contract AT(29-1)-789. J. Nucl. Mater.; 42: No. 1, 96-100(Jan 1972).

Observations were performed on Pd implanted with 300-keV helium atoms near −180°C to doses of 1 and 2×10^{18} He atoms/cm^2. Significant helium release and surface blisters were found at temperatures below 150°C. The helium release occurs in two temperature regions, one between −160 and 150°C, and another above 450°C. Approximately 30% of the implanted gas was released below 150°C, while very little further release was observed until temperatures above 450°C were reached; then, an additional 25% is released up to 750°C. Complete helium release is not achieved until above 1000°C. (D.L.C.)

13400 STUDY BY COMPUTER SIMULATION OF THE EFFECT OF NEUTRON IRRADIATION ON AN ORDERED SOLID SOLUTION. Baran, Z. (Institut de Recherches Nucleaires, Warsaw). Phys. Status Solidi (a); 8: No. 1, 53-60(16 Nov 1971). (In French).

In order to verify a previous hypothesis, according to which the neutron irradiation of an ordered alloy U_2Ti introduces a substitution-type disorder, the process of x-ray diffraction by a one-dimensional crystal was simulated by a computer. The intensities of the fundamental and substructure diffraction peaks were computed as functions of the number of fission spikes in the originally ordered alloy. The randomly distributed fission spikes are supposed to have a completely disordered substitutional structure. From the intensities, the long-range-order parameter is deduced as a function of concentration of spikes and compared with experimental results. The good fit of the theoretical curve with experimental dates confirms the adopted fission-spike model. (auth)

13401 CHANNELING OF MeV PROJECTILES IN DIATOMIC IONIC CRYSTALS. Matzke, Hj. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). Phys. Status Solidi (a); 8: No. 1, 99-109(16 Nov 1971).

The axial channeling behavior of protons and He^+ ions in the energy range 0.2 to 2.0 MeV was studied in single crystals of LiF, NaF, NaCl, KCl, MgO, and SrF_2. Data on UC, UO_2, and SiC were included for comparison. With the alkali halides LiF, NaF, NaCl, and KCl, charge buildup as well as formation of radiation damage were observed together with high values (0.15 to 0.40) and a pronounced depth dependence of the minimum aligned yield, χ_{min}. For longer exposure to the beam, the channeling behavior deteriorated until it became impossible to observe any channeling, probably due to formation of defect clusters. The other materials proved to be stable against the ion beam and yielded low values (0.03 to 0.13) and a small depth dependence for χ_{min}. The critical angles, $\psi_{\frac{1}{2}}$, were in most cases smaller than the Linhard critical angles, ψ_1. When allowing for the influence of thermal vibrations, agreement with theory was achieved for the materials of the rock-salt structure, whereas the $\psi_{\frac{1}{2}}$ values for the fluorite-type materials were consistently lower than $\alpha\ \psi_1$ by about 25%. (auth)

13402 MAGNETIC SUSCEPTIBILITY AND STRUCTURE MODIFICATIONS OF SOME IRRADIATED Re COMPOUNDS. Bunget, I. (Univ., Bucharest); Ghizdeanu, C.; Ianovici, E.; Ion, R.; Popescu, M. Phys. Status Solidi (a); 8: No. 1, 135-9(16 Nov 1971).

The influence of oxidation−reduction processes on the modifications of structure and magnetic susceptibility of some irradiated Re compounds (K_2ReCl_6 and $NaReO_4$) was investigated. The decrease of the ion magnetic moment after irradiation in a nuclear reactor and suitable annealing was ascribed to the rhenium oxidation. A diamagnetic phase ($KReO_4$) was revealed by x-ray analysis in annealed samples only. The irradiated $NaReO_4$ exhibited a weak paramagnetism that is strongly affected by annealing. (auth)

13403 ION-IRRADIATION DAMAGE OF SILICON IN THE TRANSMISSION ELECTRON MICROSCOPE. Hill, M. J. (Brown Boveri Research Centre, Baden, Switzerland). Phys. Status Solidi (a); 199-204(16 Nov 1971).

The main purposes of this paper are (a) to show that ion-irradiation damage of the specimen can occur in modern transmission electron microscopes, and must be accounted for in studies of small crystalline defects, and (b) to demonstrate that methods used to study irradiation damage in metals can usefully be applied to silicon. These methods include quantitative stereo measurements of the depth distribution of defects and dynamical-contrast experiments in the electron microscope. The defects produced by ions inside the microscope in silicon are shown to have a three-dimensional form, with interstitial character. The depth profile has a peak at ≈90Å from the surface, with some defects lying as deep as 800 Å. (auth)

13404 DISLOCATION LOOPS INDUCED BY ELECTRON IRRADIATION OF POTASSIUM CHLORIDE AT LOW TEMPERATURES. Kawamata, Y. (Tohoku Univ., Sendai). Phys. Status Solidi (a); 8: No. 1, 283-9(16 Nov 1971).

Transmission electron microscopy was used to study the microstructure of thin (001) foils of a single potassium chloride crystal damaged at −110°C by 75-keV electron irradiation. Irradiation at low intensities (about 1 mA/cm^2) produces dislocation loops having (a/2) ⟨011⟩ Burgers vectors and lying on {011} and {111} planes. The further irradiation at high intensities (0.2 to 1 A/cm^2) makes the loops move in the directions of their Burgers vectors. The loops having Burgers vectors not parallel to the foils immediately pass out of the crystals. The loops having Burgers vectors parallel to the foils remain in the crystals. (auth)

13405 EXOELECTRON EMISSION OF SILICON AND GERMANIUM AFTER BOMBARDMENT BY PROTONS OF LOW ENERGY. Zdanovich, A. G.; Kryuk, V. I.; Mints, R. I.; Milman, I. I. (Ural Polytechnical Inst., Sverdlovsk, USSR). Phys. Status Solidi (a); K27-9(16 Nov 1971).

N-type Si and Ge were bombarded by 600-keV protons at 120°C. The exoelectron emission glow curves showed two peaks; the high-temperature peak is observed only with illumination. The radiation annealing results show that the low-temperature peak is due to energy transfer to the electron during dissociation and annihilation of E centers, while the other one is due to annealing of complexes of point defects or dislocations. (D.L.C.)

13406 ELECTRON PARAMAGNETIC RESONANCE OF TERBIUM IONS IN γ-IRRADIATED CaF_2 CRYSTALS CONTAINING TWO RARE-EARTH IMPURITIES. Kornienko, L. S.; Rybaltovskii, A. O. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 7, 1609-15(Jan 1972).

Translated from Fiz. Tverd. Tela; 13: No. 7, 1919-26(Jul 1971).

An EPR investigation was made of CaF_2 (Tb, Sm) and CaF_2 (Tb, Yb) crystals grown in a fluoridizing atmosphere. Irradiation with γ rays leads to the appearance of two spectra in each of these crystals; these belong to the Tb^{4+} ions in a field of trigonal symmetry whose axis coincides with the [111] direction. Both spectra are characterized by similar parameters of the spin Hamiltonian. A study of the change in the intensities of the EPR spectra of all the observed centers under the influence of annealing of the irradiated crystals (in the range 300 to 800°K) made it possible to establish the nature of the oxidation−reduction reactions for these pairs of impurities at all annealing stages. The possible structures and mechanism of formation of Tb^{4+} centers associated with the participation of mobile interstitial F^- ions are discussed on the basis of the experimental results. (auth)

13407 THERMOLUMINESCENCE OF CaF_2:Tb^{3+} CRYSTALS. Batsanov, S. S.; Korobeinikova, V. N.; Kazakov, V. P.; Kobets, L. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 3, 265-8 (Mar 1971).

Translated from Opt. Spektrosk.; 30: No. 3, 484-9(Mar 1971).

The thermoluminescence of CaF_2: Tb^{3+} crystals is shown to be a recombination process. X-ray and uv exposures produce different thermoluminescence curves. On exposure, the charge carriers are trapped by the same trapping centers, and the difference between the kinds of exposure is in the different relative population of these centers after exposure. A change in the population of the traps is obtained also by exposure of the crystals at a different temperature. The dependence of the photoconductivity on Tb^{3+} concentration is investigated. The origin of the low- and high-temperature thermoluminescence peaks is discussed. (auth)

13408 CONDUCTION IN METAL OXIDE THIN FILMS FORMED BY OXYGEN ION IMPLANTATION. Perkins, J. G. (Univ. of Surrey, Guildford, Eng.). Thin Solid Films; 9: No. 2, 257-72(Feb 1972).

Oxygen ion implantation of thin aluminum and titanium films has shown that a wide range of resistivity material from that of the metallic state to that of the dielectric state can be produced and accurately controlled. The electrical properties of films with resistivities in the region $10^{11}-10^{12}$ Ω-cm were measured by direct and alternating current. Under dc fields a single modified form of Poole−Frenkel mechanism dominated the electronic conduction, while under ac conditions the conduction was attributed to electronic hopping between localized sites. (auth)

13409 PREFERENTIAL DEPOSITION OF SILVER INDUCED BY LOW-ENERGY GOLD-ION IMPLANTATION. Stroud, P. T. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Thin Solid Films; 9: No. 2, 273-81(Feb 1972).

It is shown that low-energy gold-ion implantation will induce the preferential deposition of silver onto a substrate of evaporated silicon oxide. The minimum dose for the effect increases monotonically with ion energy, and it is necessary to implant between 5×10^{13} and 7×10^{14} atoms cm^{-2} in the energy range 70 to 345 eV. A theory based on three-dimensional nucleation is proposed to account for the effect, and it is suggested that only atoms implanted within the first three atomic layers contribute to surface sensitization. (auth)

13410 CHEMICAL REACTIONS WITH ACCELERATED IONS: CHEMICAL EFFECTS OF $^{32}P^{+}$ IONS IMPLANTED IN NaCl SINGLE CRYSTALS. Andersen, T.; Ebbesen, A. (Univ. of Aarhus, Denmark). Trans. Faraday Soc.; 67: No. 588, 3540-9(Dec 1971).

An electromagnetic isotope separator was used for implantation of 40-keV $^{32}P^{+}$ ions in single crystals of sodium chloride. The penetration of the implanted ions and their diffusion during storage at various temperatures were measured by a new chemical sectioning technique. The chemical distribution of the ^{32}P ions was determined after dissolution of the crystals. It reflects the variation in range distribution observed by varying the angle between the incident beam and the (100) plane. Deeply penetrating tails have a high content of the $^{32}P(V)$ precursor. A close correlation is established between the $^{32}P(V)$ precursor and changes in the range distribution due to diffusion. The chemical distribution depends to some extent on reactions occurring during dissolution. Thermal- and photo-annealing show the existence of two $^{32}P(I)$ precursors. (auth)

13411 OPTICAL ABSORPTION IN FUSED SILICA DURING IRRADIATION: RADIATION ANNEALING OF THE C-BAND. Palma, G. E.; Gagosz, R. M. (United Aircraft Research Labs, East Hartford, Conn.). J. Phys. Chem. Solids; 33: No. 1. 177-89(Jan 1972).

The results of extensive measurements of the optical transmission of Corning 7940 uv-grade fused silica made during ambient and elevated temperature irradiations are described. The irradiations include high-dose-rate pulsed reactor irradiation, moderate-dose rate steady-state reactor irradiation, and a selectable-dose rate steady-state 1.5-MeV electron irradiation. The growth of the C-band absorption at 2150 Å during ambient-temperature irradiation indicates that this absorption is due to the trapping of free electrons at defects; the free electrons and defects both being generated by ionization process. During prolonged elevated-temperature irradiation, the C-band absorption reaches a steady-state value due to the combined effects of the generation and annealing of color centers. At a given dose rate, these steady-state values decrease with increasing temperature due to the corresponding increase in the annealing rate. Above a dose rate of 0.4 Mrad/sec, the steady-state absorption coefficient decreases with increasing dose rate due to radiation annealing. A mathematical model describing the temporal behavior of the C-band absorption during irradiation is also presented. (auth)

13412 ELECTRON MICROSCOPY AND ANALYSIS. Proceedings of the 25th Anniversary Meeting of the Electron Microscopy and Analysis Group of the Institute of Physics, Held at Cambridge, England, 29 June–1 July 1971. Nixon, W. C. (ed.). Conference Series Number 10. London; Institute of Physics (1971). 351p. £10. (CONF-710626).

89 papers were presented at this conference. Three were in NSA scope, and separate abstracts were prepared for them. (UK)

For abstracts of individual papers see: 13413–13415.

13413 IRRADIATION-INDUCED VOID STUDIES IN THE HIGH-VOLTAGE ELECTRON MICROSCOPE. Norris, D. I. R. (Berkeley Nuclear Labs., Eng.). pp 20-3 of Electron Microscopy and Analysis. /Nixon, W. C. (ed.). London; Inst. of Physics (1971).

From Meeting of the electron microscopy and analysis group; Cambridge, England (29 Jun 1971).

The dimensional changes of metals due to high-dose irradiation were studied using a high-voltage (1-MV) electron microscope beam. Experiments were carried out in the 280 to 480°C range on 99.995% Ni. Although electron irradiation alone does not produce voids in Ni, irradiation by gas ions followed by electron radiation does. He^{+}, Ne^{+} and Ar^{+} ions were used successfully at energies of 50 to 150 keV. Experimental procedure to determine whether the gas atoms or vacancy clusters are the controlling factor in nucleation is explained. Dislocations were found to control void growth and associated effects are discussed. Above 600°C, voids were found to anneal out of a thin Ni foil. (UK)

13414 PENETRATION OF HIGH-VOLTAGE ELECTRONS THROUGH THIN FOILS OF α-URANIUM. Foreman, A. J. E.; Hudson, B. (Atomic Energy Research Establishment, Harwell, Eng.). pp 24-6 of Electron Microscopy and Analysis. /Nixon, W. C. (ed.). London; Inst. of Physics (1971).

From Meeting of the electron microscopy and analysis group; Cambridge, England (29 Jun 1971).

The diffraction effects that occur as high-voltage electrons traverse a thin α-uranium foil were studied as uranium can be expected to produce high-voltage effects at lower electron voltages than other materials. The experimental technique was to build computer images of bend contours, as functions of beam voltage, specimen orientation, and thickness, obtained by dynamic calculations and to compare these with the same contours obtained from a JEM 7 100-kV microscope and an AEI EM 7 high-voltage microscope over a range of 50 to 1100 kV. Strong electron channeling was found throughout the range of beam voltages and the results are interpreted in detail in terms of the optimization of absorption and excitation of the various Bloch wave components of the total beam. It was found possible to obtain information relevant to lower atomic number materials at higher acceleration voltages, and penetrations measured under various conditions are discussed. It is believed that in very light materials, there is a considerable thickness gain in going to >1-MeV beam voltage but that medium materials have a marginal, and high atomic number materials very little, gain in penetration. (UK)

13415 ELECTRON MICROSCOPY OF MECHANICAL AND IRRADIATION DEFECTS IN ALKALI HALIDES. Hobbs, L. W. (Oxford Univ.). pp 178-81 of Electron Microscopy and Analysis. /Nixon, W. C. (ed.). London; Inst. of Physics (1971).

From Meeting of the electron microscopy and analysis group; Cambridge, England (29 Jun 1971).

Special techniques developed for successful investigation of lattice defects in alkali halides are described and some representative preliminary results outlined. The preparation of thin foils of the alkali halides is detailed and the electron damage process described by the Pooley–Hersh (1966) mechanism. Observable damage was found to be reduced by the reduction of defect mobilities, reduction of ionization cross section, and impurity doping. Analysis of radiation damage products is described and dislocation observations discussed. External irradiation was by electrons, neutrons, ions, x, and γ rays. (UK)

13416 PLASMON EXCITATION IN COLLOIDAL GRAPHITE PRODUCED BY X RAYS. Koumelis, C.; Leventouri, D.; Alexopoulos, K. (Univ. of Athens). Phys. Status Solidi (b); K89-91 (1 Aug 1971).

X-ray scattering experiments using the Cr K_β line were extended to the scattering angle $\varphi = 0°$. No new component in the vicinity of the Cr K_β line was found for polycrystalline graphite, but a faint line shifted by 13 ± 1 eV was found for colloidal graphite. The energy of the surface plasma oscillation is determined to be 23 ± 1.7 eV, in agreement with the electron-energy-loss results. (D.L.C.)

13417 NEW PARAMAGNETIC SILVER CENTRES IN KCl CRYSTALS. Melnikov, N. I.; Baranov, P. G.; Zhitnikov, R. A. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Status Solidi (b); 46: No. 2, K73-6(1 Aug 1971).

KCl crystals containing 0.2 to 0.3 mole % AgCl were x-irradiated at room temperature. Bleaching at the F-band maximum results in considerable changes in the EPR and absorption spectra, with almost total disappearance of the Ag_K^0 and F-center spectra and appearance of Ag_F^0 centers. Bleaching by B light (288 nm) forms neutral Ag atoms (Ag_a^0) with a band at 337 nm. Bleaching by F light, D_1 light, B light, and E light results in the formation of Ag_2^+. The role of Ag_F^0 as an intermediate stage in the B-center formation is suggested. (D.L.C.)

13418 USE OF A SMALL ANGLE X-RAY SCATTERING SYSTEM TO OBSERVE DIFFUSE SCATTERING IN NEUTRON-IRRADIATED COPPER. Baldwin, T. O. (Southern Illinois Univ., Edwardsville); Thomas, J. E.; Wei Huu Kou. Phys. Status Solidi (b); K53-7(1 Aug 1971).

The diffuse x-ray scattering in the neighborhood of the 111 Bragg reflection was studied at small angles in Cu crystals after irradiation to 10^{19} cm^{-2} (E > 1.0 MeV). The asymmetry in the diffuse scattering was measured using the Kα doublet and the Kβ lines. The shift in the diffuse scattering was determined to be $\sim 3.5 \times 10^{-4}$ radian. The true shape of the diffuse scattering on both sides of the Bragg peak was observed for the 111 reflection. The results are in agreement with earlier results obtained with a double-crystal diffractometer (Phys. Rev. B3, 1167(1971)). (D.L.C.)

13419 X-RAY COLORATION OF Eu^{2+}-DOPED KCl. Chowdari, B. V. R.; Itoh, N. (Nagoya Univ., Japan). Phys. Status Solidi (b); 46: No. 2, 549-57(1 Aug 1971).

The irradiation effects in KCl doped with Eu^{2+} were studied by measuring the optical absorption and EPR spectra. Exposure to x rays at room temperature and dry-ice temperature leads to a decrease in the intensity of the absorption bands and the EPR lines of Eu^{2+}. The decrease in Eu^{2+} is partially recovered by F-bleaching at room temperature. Conversion of the Eu^{2+} to Eu^{3+} by trapping a hole at room temperature and dry ice temperature and the conversion of the Eu^{3+} to Eu^{2+} by trapping an electron at room temperature is suggested. X irradiation at liquid-nitrogen temperature produced higher concentration of the Hayes–Nichols center than the x irradiation at dry-ice temperature. This dif-

ference in the formation rate of the Hayes–Nichols center is attributed to the difference in the Eu^{2+} concentration at two different temperatures. A plausible model for the Hayes–Nichols center is suggested. (auth)

13420 EPR STUDY OF IRRADIATION PRODUCTS OF NO_2^- AND NO_3^- IN KN_3. Fuller, A. M.; Tarr, C. E. (Univ. of Maine, Orno). J. Chem. Phys.; 56: No. 1, 438-40(1 Jan 1972).

Single crystals of KN_3 doped with KNO_2 and KNO_3 were irradiated with ultraviolet light and x rays. EPR investigations of the paramagnetic centers stable at room temperature indicate that NO_2^- is the precursor for the NO_2 and NO_2^{2-} centers observed and that NO_3^- is the precursor for the NO_2^{2-} center only. (auth)

13421 LIGHT-SENSITIVE DEFECT FORMATION BY ELECTRON AND NEUTRON IRRADIATION OF n- AND p-TYPE GERMANIUM NEAR 80°K. Stein, H. J. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys.; 43: No. 1, 138-44(Jan 1972).

Measurements of the electrical conductivities and Hall coefficients for neutron-irradiated (76°K) and electron-irradiated (80°K) n- and p-type Ge were made as a function of illumination and isochronal annealing (80 to 700°K) to investigate the characteristics of neutron-produced defect clusters in Ge. For p-type Ge, there is no effect of illumination immediately following either electron or neutron irradiation, but such a dependence is observed after the 140°K annealing period. This illumination dependence anneals out between 200 and 240°K. For n-type Ge, the effect of illumination on the electrical properties is significantly larger following neutron irradiation than following electron irradiation. Eighty percent of the neutron-produced illumination sensitivity anneals out between 200 and 400°K. The electrical conductivity in neutron-irradiated n-type Ge is near a degradation maximum after annealing to 240°K, whereas it is essentially recovered to the preirradiation value in p-type Ge. Furthermore, reverse effects in neutron-irradiated n-type Ge for annealing between 150 and 220°K contrast with a 100 to 200°K recovery after electron irradiation. These results are interpreted as evidence for the neutron formation of high-resistivity p-type defect clusters which increase their p-type character upon annealing to ~200°K, and recover by vacancy liberation between ~200 and 450°K. Annealing effects between 400 and 600°K are interpreted to involve defect-impurity complexes in both electron- and neutron-irradiated n-type Ge. (auth)

Physical Properties

Refer also to abstracts 12683, 12728, 13130, 13139, 13326, 13844–13846, and 13862.

13422 (JINR–E4-6089) THEORY OF A NONCOLLINEAR FERROMAGNETISM OF THE U_3X_4 COMPOUNDS. Przystawa, J.; Praveczki, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 32p. Dep. NTIS (U. S. Sales Only).

In order to describe magnetic properties of U_3X_4 compounds a model is proposed, which contains, besides isotropic exchange, uniaxial exchange anisotropy and three-axial crystal field term. Semiclassical considerations lead to a noncollinear, three-axial, ground-state configuration and stability conditions for such an ordering are found. The behavior of the system with the external magnetic field of different orientations is discussed at zero temperature. (auth)

13423 (LA-DC-12885) NEUTRON DIFFRACTION STUDIES ON DySb, NdSb, AND CeSb. Nereson, Norris; Struebing, Vernon (Los Alamos Scientific Lab., N. Mex.). [1971]. 5p. (CONF-711108-3). Dep. NTIS.

From Conference on magnetism; Chicago, Ill. (16 Nov 1971).

Neutron-diffraction data from powder samples of DySb, NdSb, and CeSb confirm antiferromagnetic ordering below Neel temperatures of 12, 16, and 18°K. The magnetic cell of DySb has dimensions twice that of the chemical cell; a possible antiferromagnetic structure has spins ferromagnetically aligned in each (111) magnetic plane, with the spins in adjacent (111) planes having opposing directions. The NdSb magnetic cell has tetragonal symmetry and the same lattice constant as the cubic chemical cell. The antiferromagnetic arrangement has ferromagnetic sheets parallel to the (001) planes with the spin direction [001] alternating from one layer to the next. The ordered moment in DySb is $8.9 \pm 0.3\ \mu_B$ and $2.8 \pm 0.2\ \mu_B$ in NdSb. The CeSb magnetic reflections can be indexed as a modulated wave propagating along the [110] direction with a wavelength of $2.7a_0$ or 17.5 ± 0.5 Å. All of the CeSb magnetic reflections do not conform to a simple modulated structure. Assuming a helical spin structure with the spin axis in the [001] direction yields an ordered moment of $1.9 \pm 0.2\ \mu_B$. (auth)

13424 (SC-T-713082) ELECTRICAL RESISTIVITY OF THE HYDRIDES OF THE TRANSITION METALS. Nemchenko, V. F. Translated by Patricia Newman (Sandia Labs., Albuquerque, N. Mex.), from Metallofizika; No. 29, 125-30(1970). 14p. Dep. NTIS.

The hydrogen occlusion properties of the transition metals and their relationship to the d states are discussed. The specific resistivity is derived as a function of the hydrogen content, assuming the hydrogen ions to be impurity scattering centers, the hydrogen s electrons to be shifted into the hydride nd and (n + 1)s conduction bands, and the lattice structure to be unchanged. The effect of interstitial H atoms on the resistivity is evaluated, using the theory of residual resistivity in alloys. Changes in the density of states are also considered. (D.L.C.)

13425 AMORPHOUS FERROMAGNETIC Fe–P–B ALLOYS PREPARED BY A NEW TECHNIQUE OF SPLAT COOLING. Yamauchi, Kazushi; Nakagawa, Yasuaki (Gakushuin Univ., Tokyo). Jap. J. Appl. Phys.; 10: No. 12, 1730(Dec 1971).

An apparatus for modified splat cooling is described, which uses a commercial plasma jet furnace and a copper plate for clapping the molten alloy on the electrode. In this way, a foil <0.1 mm thick is formed. The properties of amorphous $Fe_{80}P_{13}B_7$ alloys prepared in this way are described: the electrical resistance and magnetization both exhibit abrupt changes on heating to 410°C, indicating this to be the crystallization temperature. The Curie point for the amorphous state is ~360°C, as contrasted to the Curie points 500 and 750°C for the two ferromagnetic phases in the crystalline state. (D.L.C.)

13426 $Ba_3CaU_2O_9$ AND $Ba_3SrU_2O_9$. Kemmler-Sack, S.; Wall, I. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 26b: No. 11, 1089-90(Nov 1971). (In German).

The compounds $Ba_3CaU_2O_9$ and $Ba_3SrU_2O_9$ crystallize in an ordered cubic perovskite lattice. According to the results of the magnetic and optic investigations, both compounds contain U(V) in a distorted octahedral coordination. (auth)

13427 ELECTRICAL RESISTIVITY AND THE DEPRESSION OF THE NEEL TEMPERATURE IN Cr–Mo AND Cr–Fe. Mitchell, M. A.; Goff, J. F. (Naval Ordnance Lab., Silver Spring, Md.). Phys. Rev., B; 5: No. 3, 1163-70(1 Feb 1972).

Existing data are used to show that Mo and Fe impurities cause the Néel temperature T_N of Cr to decrease at almost exactly the same rate up to 10 at. %. Elements with a higher valence than Cr generally increase T_N. It is suggested that two Fe electrons are localized and produce a localized magnetic moment, for which experimental evidence already exists. The effective valence of Fe would then be similar to that of Mo. In order to investigate the similarities and differences of Cr–Fe and Cr–Mo, electrical-resistivity measurements were made on two Cr alloys with 9.35 at.% Mo and 9.35 at.% Fe, respectively, from 2 to 300°K. For Cr–Mo, T_N = 197°K, and for Cr–Fe, T_N = 181°K. At 0 and 200°K the resistivity of Cr–Fe is 12.6 and 3.2 times higher, respectively, than that of Cr–Mo. It is suggested that localized magnetic moments at Fe sites combined with atomic disorder produce a large, nearly temperature-independent spin-disorder scattering in Cr–Fe. A simple model of electrical conduction is employed to explain the temperature dependence of the electrical resistivity. Below T_N, an energy gap with a BCS temperature dependence opens up over a part of the Fermi surface, and conduction takes place in two bands. As a result of the gap, electrons in the magnetic band are thermally frozen out with decreasing temperature, which leads to the rise in the resistivity just below T_N. The 0°K gap is estimated to be 0.14 eV for Cr–Mo and 0.072 eV for Cr–Fe. Pure Cr and Cr–Mo have nearly the same balance of conduction between the magnetic and nonmagnetic bands. In Cr–Fe, the balance is shifted toward conduction in the magnetic band. (auth)

13428 MAGNETIC SUSCEPTIBILITY AND LOW-TEMPERATURE SPECIFIC HEAT OF DILUTE TRANSITION-METAL ALLOYS. Claus, Helmut (Univ. of Illinois, Champaign). Phys. Rev., B; 5: No. 3, 1134-43(1 Feb 1972).

Magnetic-susceptibility measurements between 4 and 800°K and specific-heat measurements between 1.5 and 4.2°K are reported for a series of dilute Rh–Mn, Mo–Fe, Mo–Co, and Au–Fe alloys in the concentration range 0.02 to 0.7 at. %. The solute susceptibility $\Delta\chi$ of all alloys shows local-moment behavior and scales with the concentration over a wide concentration range; but large deviations from simple Curie–Weiss behavior, qualitatively the same for all alloys, are observed. This deviation consists of a rapid increase of $\Delta\chi$ at low temperatures. A pronounced field dependence of $\Delta\chi$ and large specific-heat anomalies at these temperatures strongly suggest that this rapid increase in $\Delta\chi$ arises from solute–solute interactions. This anomalous part of $\Delta\chi$ can readily be separated from the part due to isolated solute atoms.

The conclusion is drawn that scaling of the solute susceptibility with concentration does not necessarily signify that the alloys are "dilute" in the conventional sense. (auth)

13429 GIANT MAGNETOSTRICTION IN CUBIC RARE EARTH–IRON COMPOUNDS OF THE TYPE RFe_2. Koon, N. C.; Schindler, A. I.; Carter, F. L. (Naval Research Lab., Washington, D. C.). Phys. Lett.; 37A: No. 5, 413-14(20 Dec 1971).

Magnetostriction measurements on the cubic Laves-phase compounds $DyFe_2$, $HoFe_2$, and $ErFe_2$ over the temperature range 77 to 300°K are reported. The magnetostriction of $DyFe_2$ at 300°K in a field of 17.5 kOe is 220×10^{-6}, which is the largest room-temperature value yet observed for a polycrystalline metal. (auth)

13430 ACOUSTIC-PHONON INSTABILITY AND CRITICAL SCATTERING IN Nb_3Sb. Shirane, G.; Axe, J. D. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 27: No. 26, 1803-6(27 Dec 1971).

Neutron-scattering experiments on Nb_3Sn show the drastic softening of the [110] acoustic shear modes as well as an unusual frequency response (a central peak in addition to the phonon side bands) near the phase transition at 45°K. A model involving coupling of the bare phonon to other fluctuations with a Debye-like frequency spectrum is proposed which correctly describes the observed cross section as a function of temperature. (auth)

13431 KONDO EFFECT IN ZnMn. Newrock, R. S. (Rutgers–The State Univ., New Brunswick, N. J.); Serin, B.; Vig, J.; Boato, G. J. Low Temp. Phys.; 5: No. 6, 701-10(Dec 1971).

The magnetic suceptibility of Zn alloys containing 7.6 to 182 ppM Mn was measured in the range 1.4 to 4.2 K. The zero-field susceptibility can be described by a Curie–Weiss law with a concentration-independent intercept on the temperature axis, which yields a Kondo temperature $T_k = 0.24$ K. A value for the effective number of Bohr magnetons on a Mn atom of p = 4.66 is found. Resistivity was measured on specimens containing 7.8 to 38 ppM Mn in the range 0.1 to 4.2 K. The resistivity of all specimens was proportional to log T at high temperatures but, except for the lowest concentration specimen, it showed evidence of ordering below 0.5 K. The data for the 7.8-ppM Mn specimen showed no evidence of ordering down to 0.1 K, and could be fitted to the formula of Hamann. Allowing for potential scattering, the resistivity at 0 K is found to be 45 $\mu\Omega \cdot$ cm/at. % Mn. This value is in agreement with d-wave unitarity limit when corrected for the appreciable deviation of the Fermi surface in zinc from a free-electron sphere. (auth)

13432 CONDUCTIVITY STUDIES IN EUROPIUM OXIDE. Oliver, M. R.; Dimmock, J. O.; McWhorter, A. L.; Reed, T. B. (Massachusetts Inst. of Tech., Lexington). Phys. Rev., B; 5: No. 3, 1078-98(1 Feb 1972).

The electrical and optical properties of EuO were studied in order to help determine conduction mechanisms. A strong relationship between growth parameters and electrical behavior is noted. Free-carrier absorption below the band edge in energy is observed in moderately conducting crystals. By comparing optical and electrical results, an experimental determination is made of carrier-density and scattering-time contributions to resistivity behavior. The carrier-density variations are explained in terms of an earlier proposed model, which is developed here. The model consists of a donor-trap level, believed to be caused by an oxygen vacancy, which is above the conduction-band edge at low temperature, but crosses below it (near 50°K) with increasing temperature. Magnetoresistance and pressure results are presented that strongly support the model. (auth)

13433 $O_{II,III}$ AND $N_{VI,VII}$ X-RAY EMISSION BANDS OF THE TRANSITION METALS IN THE THIRD LONG PERIOD. Rudnev, A. V.; Fomichev, V. A.; Shulakov, A. S.; Nemnonov, S. A. (Leningrad State Univ. Inst. of Physics of Metals, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 7, 1724-6(Jan 1972).

Translated from Fiz. Tverd. Tela; 13: No. 7, 2053-5(Jul 1971).

The x-ray emission spectra in the long-wave region 140 to 800 Å were obtained and identified for the elements Lu, Hf, Ta, W, Ir, Pt, and Au. The spin-doublet splitting $O_{II}(5p_k)$ and $O_{III}(5p_k)$ as well as the $N_{VI}(4f_k)$ and $N_{VII}(4f_k)$ levels of these elements were estimated. An anomalous relationship between the intensities of the O_{II} and O_{III} bands and also the N_{VI} and N_{VII} bands was found. The experimental conditions for finding and placing the maxima of the spectra are given. (auth)

13434 SEEBECK COEFFICIENT OF BINARY CHROMIUM ALLOYS CONTAINING MOLYBDENUM OR TUNGSTEN. Arajs, Sigurds; Anderson, Elmer E.; Rao, K. V. (Clarkson Coll. of Tech., Potsdam, N. Y.). Contract AT(30-1)-4079. J. Less-Common Metals; 26: No. 1, 157-64(Jan 1972).

The Seebeck coefficient (S) of Cr alloys containing 0.6, 3.2, 5.1, 6.9, or 8.8 at. % Mo or 0.3, 0.7, 1.0, or 3.4 at. % W was measured as a function of temperature (T) between 50 and 350°K. The S vs T curves showed large anomalies (increases in S) in this temperature range due to the transition from the paramagnetic to the antiferromagnetic state, made up of transverse spin-density waves incommensurable with the chromium lattice. In the paramagnetic region Cr–Mo alloys approximately obey the Nordheim–Gorter rule. The Cr–W alloys do not obey this relation because of the anomalous behavior of the electrical resistivity with respect to the composition in the paramagnetic state. The increase in S, due to the onset of the antiferromagnetic state, can be approximately correlated with the increase in the electrical resistivity in Cr–W alloys. The Cr–Mo solid solutions show more complicated behavior. (auth)

13435 MAGNETIC AND NEUTRON DIFFRACTION STUDIES ON $Pr_{0.333}Cu_{0.1}Al_{0.566}$. Oesterreicher, Hans (Oregon Graduate Center, Beaverton). J. Less-Common Metals; 26: No. 1, 165-8 (Jan 1972).

The nature of magnetic order in $Pr_{0.333}Cu_{0.1}Al_{0.566}$ was studied by neutron-diffraction methods. The copper-containing alloy was chosen in order to produce a nonmagnetic Cu–Al matrix, which would not unnecessarily complicate the situation of crystal field effects. However, the peak in magnetization with temperature in the Pr–Cu–Al alloy seemed to originate mainly from a crystal-field effect. It is believed that the assistance of the external field in populating magnetic states may also cause increases in magnetic moment with field. An upturn of magnetic moment in high fields below 4.2°K, on the other hand, seemed to indicate an enhancement of the magnetic exchange which, at still lower temperatures, might more and more overcome the effects of the crystal field and result in a relatively strong-exchange-enhanced ferromagnet. (P.C.H.)

13436 N-TYPE CONDUCTIVITY IN STABILIZED ZIRCONIA SOLID ELECTROLYTES. Etsell, T. H.; Flengas, S. N. (Univ. of Toronto). J. Electrochem. Soc.; 119: No. 1, 1-7(Jan 1972).

The n-type conductivity in commercially available stabilized zirconia electrolyte tubes was studied from 600 to 1400°C using three independent techniques: emf measurements on H_2-H_2O mixtures, coulometric titration of oxygen out of liquid silver or copper, and electrolyte breakdown in gas mixtures with low oxygen activities. From the coulometric titration results, $\log P_\theta = -(54.5 \times 10^3/T) + 14.0$, where P_θ is the oxygen pressure at which the ionic and n-type conductivities are equal. Determinations of the electrolyte breakdown voltage permit reasonable estimates of P_θ to be made. Disagreement between the first two techniques was found which enabled discrepancies in the literature to be resolved. (auth)

13437 DISPERSION RELATIONSHIP FOR THE PHONON SPECTRUM OF NIOBIUM IN THREE HIGH-SYMMETRY DIRECTIONS. Korsunskii, M. I.; Genkin, Ya. E.; Markovnin, V. I.; Zavodinskii, V. G.; Satsuk, V. V. (Inst. of Nuclear Physics, Alma Ata, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 7, 1793-5(Jan 1972).

Translated from Fiz. Tverd. Tela; 13: No. 7, 2138-40(Jul 1971).

The dispersion curves of the phonon spectrum of Nb are calculated on the basis of a pseudopotential method, assuming the existence of locally bonding electrons. The calculated curves are in agreement with experiment, and the number of locally bonding electrons per atom, 3.89, agrees with the value of 3.8 ± 0.2 from x-ray spectra. (D.L.C.)

13438 EFFECTIVE MAGNETIC FIELDS AT THE NUCLEI OF EUROPIUM AND SCANDIUM ATOMS DISSOLVED IN GADOLINIUM. Nikulin, E. I.; Patrikeev, Yu. B. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 7, 1819-20(Jan 1972).

Translated from Fiz. Tverd. Tela; 13: No. 7, 2163-4(Jul 1971).

The specific heats of ferromagnetic Gd–10% Sc and Gd–10% Eu alloys were measured at 0.07 to 0.17°K. From the results, the effective fields were found to be 26 ± 6 kOe for Sc and 117 ± 20 kOe for Eu. (D.L.C.)

13439 REANALYSIS OF THE SPECIFIC HEAT OF SOME DILUTE Au–V ALLOYS. Van Dam, J. E. (Kamerlingh Onnes Laboratorium, Leiden). Phys. Lett.; 38A: No. 1, 19-20(3 Jan 1972).

It is shown that the impurity contribution to the electronic specific heat of Au–V alloys is proportional to the concentration, if a change in the lattice contribution is assumed in the alloys. (auth)

13440 CONDUCTIVITY OF THE SOLID ELECTROLYTE $Th_{0.8}Y_{0.2}O_{1.9}$ AT LOW TEMPERATURES. Reetz, Teja; Ullmann,

Helmut (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Chem.; 11: No. 7, 277-8(Jul 1971). (In German).

Electric conductivity of thorium oxide–yttrium oxide solid electrolytes was measured in a Wheatstone bridge at low temperatures and in oxygen of approximately 10^{-5} atm. The temperature studied ranged from about 150 to 600°C. Within this range, the logarithm of conductivity decreased linearly with the reciprocal value of the temperature. The measured linear course of conductivity is valid only for the particular oxygen pressure, temperature, and composition of the solid electrolyte. (H.B.G.)

13441 VIBRATIONAL SPECTRUM AND SPECIFIC HEAT OF TANTALUM. Pal, Satya (Allahabad Univ., India). Can. J. Phys.; 49: No. 21, 2727-30(1 Nov 1971).

The vibrational spectrum and specific heat of tantalum are calculated on the basis of the lattice-dynamical model of Sharma and Joshi. The calculated specific heat and the corresponding equivalent Debye temperature show fair agreement with the experimental data of Clusius and Losa. (auth) (Canada)

13442 APW CALCULATION FOR BAND STRUCTURE OF CADMIUM. Pendyala, Subrahmanyam; Pant, M. M.; Tong, B. Y. (Univ. of Western Ontario, London). Can. J. Phys.; 49: No. 21, 2633-5(1 Nov 1971).

An APW calculation of the band structure of cadmium is reported. The calculated band structure is similar to that obtained by others from pseudopotential calculations and explains some of the observed peaks in the optical absorption spectrum in terms of direct transitions. (auth)

13443 ELECTRICAL RESISTIVITY OF VR-20 TUNGSTEN–RHENIUM ALLOY AT HIGH TEMPERATURES. Vermogradskii, V. A.; Chekhovskoi, V. Ya. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 2, 399-401 (Mar-Apr 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 2, 438-40(Mar-Apr 1971).

The electric conductivity of W–20% Re alloy was measured from 1200 to 2800°C. Equipment and procedures for eliminating systematic errors in the measurements are described. (T.F.D.)

13444 MAGNETIC PROPERTIES OF VARIABLE-COMPOSITION PHASES OF TITANIUM NITRIDE, TITANIUM DIBORIDE, AND ALLOYS IN THE SYSTEM Ti–B–N. Aivazov, M. I.; Gurov, S. V.; Domashnev, I. A.; Kireeva, I. M. (Inst. of New Chemical Problems, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 7, 1042-5(Jul 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 7, 1176-9(Jul 1971).

The magnetic susceptibility of the TiN compositions in Ti–B–N showed that lattice defects have a marked influence on the formation of "quasi-localized" electron states. In TiB_2 compositions the presence of a partly filled 2p zone led to an increase in the Pauli paramagnetism at low temperatures and to the appearance of two types of carriers at high temperatures. (auth)

13445 RESISTANCE OF ANODIC FILMS ON TITANIUM AND SOME OF ITS ALLOYS. Radovici, O.; Popa, M. V. Rev. Coroz.; 1: No. 1, 9-15(Jan-Mar 1971). (In Rumanian).

The potentiostatic technique was used to study the resistance of passive anodic films on titanium and some alloys (Ti + Mo; Ti + Ni; Ti + Pd; Ti + V) in calcium halide solutions at temperatures higher than 100°C. It was found that the passive film formed on the surface of the working electrode had a rather high resistance about 10 to 12 V, i.e., a lower value than the results obtained in acid media. The results of the determinations have shown that the breaking potential of the passive film is dependent on the nature of ions, the halogen, temperature, and alloy nature. The results also show that the titanium alloys can be used in a halide solutions in wide potential fields among which Ti + Ni was particularly remarkable. (tr-auth)

13446 SEMICONDUCTOR-METAL PHASE TRANSITION IN A STRONG ELECTRIC FIELD IN V_2O_3. Andreev, V. N.; Aronov, A. G.; Chudnovskii, F. A. (Inst. of Semiconductors, Leningrad). Zh. Eksp. Teor. Fiz.; 61: No. 2, 705-17(Aug 1971). (In Russian).

The electric conductivity in a strong electric field in V_2O_3 was investigated experimentally in the temperature range from 4.2 to 150°K. A shift of the phase-transition point in an electric field was observed down to helium temperatures. It was found that magnetic field strengths up to 240 kOe do not affect the phase-transition temperature. The results of the work are discussed on the basis of the strong electron–phonon coupling exciton model. The transition point shift in an electric field is ascribed to the effect of deformations due to the piezo effect. (auth)

13447 HALL EFFECT AND ANISOTROPIC RELAXATION TIMES IN α-PHASE AgCd, AgIn, AgSn, AND AgSb ALLOYS. Alderson, J. E. A.; Hurd, C. M. (National Research Council of Canada, Ottawa). Can. J. Phys.; 48: 2162-8(15 Sep 1970). (NRCC-11444).

The Hall resistivities of polycrystalline samples of the series Ag(Cd → Sb) were measured in the temperature range 4.2 to 80°K, and in the field range 2 to 15.17 kG. The solute concentration ranges between 273 and 6715 atomic ppM. Special consideration was given to the establishment of the low-field condition, for which the negative Hall coefficients of the Ag(Cd → Sb) series at 4.2°K are found to be 9.49, 9.59, 9.67, and 9.77×10^{-11} m^3 A^{-1} sec^{-1}, respectively, with an accuracy of ±0.04 in these units. Using the model of Dugdale and Firth, the corresponding values of the ratio τ_N/τ_b are 0.64, 0.57, 0.52, and 0.47, respectively. It is shown that there is qualitative agreement between the dependence of τ_N/τ_b upon solute valence and that expected from the known electronic structure of the solutes. Results are also given for the field dependence of the transverse magnetoresistance shown by the samples at 4.2°K, which have been used to establish the low-field condition. (auth)

13448 AUGER/LEED INVESTIGATION OF Sn ON Mo(100). Jackson, A. G.; Hooker, M. P. (Systems Research Labs., Inc., Dayton, Ohio). Surface Sci.; 27: No. 1, 197-210(Aug 1971).

Growth of tin on the Mo(100) surface was studied, using LEED/Auger techniques. Only one structure, a $c(2 \times 2)$, was found that could be associated with a Sn–Mo compound. In the presence of oxygen, the growth of the $c(2 \times 2)$ is inhibited unless the Mo is heated to 830°C in the presence of a low coverage of oxygen. Tin oxide will form but is decomposed to free tin plus low oxides of Mo. Attempts to form Mo_3Sn (β-W structure) were unsuccessful. Carbon inhibits the growth of any Sn–Mo ordered structures. (auth)

13449 SPUTTER CLEANING AND ETCHING OF CRYSTAL SURFACES (Ti, W, Si) MONITORED BY AUGER SPECTROSCOPY, ELLIPSOMETRY, AND WORK FUNCTION CHANGE. Smith, Tennyson (North American Rockwell Science Center, Thousand Oaks, Calif.). Surface Sci.; 27: No. 1, 45-59(Aug 1971).

Surfaces of Ti, W, and Si were cleaned in an ultrahigh vacuum system by ion bombardment with Cs^+ and Ar^+. Also, a thin film (220 Å) of Si_3N_4 on Si was etched off by sputter-etching with Cs^+ at 500 V. The surface composition was monitored with Auger spectroscopy, film thickness with ellipsometry, and work function changes with surface potential-difference measurements. Surface contamination on Si, Ti, and W samples is mostly C, probably from hydrocarbons used for cleaning or as adsorbed CO. The C and O contamination (~ 12 Å) on Si_3N_4/Si can be removed with about 6.2 μA-min/cm^2 of bombardment with Cs^+ at 500 V. At 800°C, no Cs is left on the sample but if the sample is near room temperature, Cs is left embedded in the sample. C and O contamination can be removed from the surface of W and Ti by ion bombardment with Cs^+ or Ar^+. However, at low temperatures these ions are left embedded in the Ti substrate. The embedded Cs or Ar change the work function and ellipsometer values and therefore must be removed by annealing at high temperature. Ti presents the special problem that, during the anneal, Cl and S segregate and cover the surface even though the bulk concentration is ~0.1 ppm. A minimum of contamination (<0.1 monolayer) by Ar, Cl, and S is obtained by bombarding with Ar^+ at about 525°C. Analysis of the composition of thin films can be made by monitoring the surface composition by Auger spectroscopy as the film is sputter-etched away. The sputter-etching efficiency for 500-V Cs^+ to remove Si_3N_4 from Si_3N_4/Si is between 0.55 and 0.73 Å (μA-min/cm^2) or about 4 atoms/ion. Since the ion current ~ 1 μA/cm^2, it takes about 15 min to remove 10 Å. The conductivity of the SiO_2 is much larger than for the Si_3N_4 and much larger ion currents and sputter-etching rates could be obtained. (auth)

13450 SPIN-DEPENDENT TREATMENT OF SURFACE-STATE RESONANCES IN LEED. Jennings, P. J. (Univ. of New South Wales, Kensington, Australia). Surface Sci.; 27: No. 1, 221-4(Aug 1971).

Surface-state resonances for Cu(001) were computed, using the spin-dependent model and a self-consistent APW potential. For normal incidence, the resonance was found to be slightly narrower than that computed for the nonrelativistic model. No spin polarization was predicted for the specular beam at normal incidence. (D.L.C.)

13451 ADSORPTION ON SINGLE-CRYSTAL PLANES OF TUNGSTEN. I. NITROGEN. Adams, D. L.; Germer, L. H. (Cornell Univ., Ithaca, N. Y.). Surface Sci.; 27: No. 1, 21-44 (Aug 1971).

Flash desorption experiments indicate that nitrogen is adsorbed with high sticking probability on W(100), (310), and (210) at 300°K, to give a single binding state on each plane. Saturation coverage is believed to be half a monolayer of atoms on each plane. LEED observations show that the surface structures are double spaced along [001] directions on each plane, and single spaced along the next most closely packed surface directions, $[0\bar{1}1]$, $[\bar{1}31]$, and $[\bar{1}20]$, respectively. On W(310) and (210), surface interactions over 10.5 Å and 7.1 Å, respectively, are required to produce the observed structures. After adsorption at 300°K the half-order diffraction features are weak and diffuse for (310) and (210), but upon anneal they become strong and sharp. The work function change produced by adsorption at 300°K is a decrease on (100) and an increase on (310) and (210), the maximum changes being −0.60, +0.20, and +0.27 eV. Subsequent anneal reduces the increase in work function on (310) and (210), coincident with the appearance of sharp LEED patterns. No change of work function with anneal occurs for (100) which is correlated with the observation that the LEED pattern from (100) is strong even before anneal. The present data, together with previous adsorption studies on tungsten planes, suggest that rapid adsorption of nitrogen at 300°K occurs only on planes that contain 4-coordinate sites, as found on W(100). Thus prediction can be made of the reactivity of a given plane, W(hkl), toward nitrogen at 300°K. (auth)

13452 RESISTIVITY OF SOLID Be, Mg, AND Zn. Borchi, E.; De Gennaro, S.; Tasselli, P. L. (Univ., Florence). Phys. Status Solidi (b); 46: No. 2, 489-94(1 Aug 1971).

A theoretical study is made of the resistivities of the solid hcp metals Be, Mg, and Zn. Information about the lattice dynamics is derived from inelastic neutron scattering, using a slight modification of the Gilat–Raubenheimer computer program for calculating the frequency-distribution functions. Empirical and Heine–Animalu pseudopotentials are used to calculate the electron–phonon coupling. Umklapp processes are explicitly evaluated. Good agreement is obtained with experimental data except in the low-temperature region. (auth)

13453 IMPURITY CONDUCTION IN Ti-DOPED VO_2 STUDIED BY MICROWAVE FREQUENCY CONDUCTIVITY. Kabashima, Shigeharu; Goto, Tsuneaki; Nishimura, Katsuyuki; Kawakubo, Tatsuyuki (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 32: No. 1, 158-63(Jan 1972).

The dc and 24-GHz conductivities of VO_2 containing various amounts of Ti were measured below the semiconductor-to-metal transition point. Above 290°K, the activation energy for dc conductivity is not affected by the small amounts of Ti impurity and the 24-GHz conductivity coincides with the dc conductivity. The pronounced frequency dispersion of conductivity is observed at low temperature, where the impurity conduction arises from the hopping motion of electrons between impurity sites. The 24-GHz conductivity can be explained as a function of temperature by the formula expressing the dielectric loss due to the hopping diffusion of electrons between pair centers given by Pollak. (auth)

13454 MAGNETIC PHASE DIAGRAM OF THE UAs–UP SOLID SOLUTIONS. Leciejewicz, J. (Inst. of Nuclear Research Swierk, Poland); Murasik, A.; Palewski, T. Phys. Status Solidi (b); 46: No. 2, K67-70(1 Aug 1971).

A neutron-diffraction study was made of the UAs–UP system at 4.2, 96, and 293°K. The results show the existence of a continuous series of solid solutions. Néel temperatures and magnetic transition points were determined. The abrupt change in the M 100 reflection intensity for $0.4 < x < 1$ in $UAs_{1-x}P_x$ is discussed. (D.L.C.)

13455 EFFECT OF THE STATE OF A TUNGSTEN SURFACE ON THE EMISSION OF THIN FILMS IN THE W–Cs SYSTEM. Kuznetsov, V. A. (Moscow Physical-Technical Inst.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 6, 1434-40 (Dec 1971).

Translated from Fiz. Tverd. Tela; 13: No. 6, 1715-22(Jun 1971).

The emission of electrons from cesium films on tungsten was studied in an electron field-emission projector in relation to the vacuum conditions and the treatment of the surface (field-evaporation at 1000°K). The structure of the surface was specially studied in a hydrogen-ion projector. It was found that at 10^{-7} mm Hg, the time dependence of the work function $\varphi(t)$ of cesium films on tungsten has no minimum, which appears beginning with a pressure of 10^{-8} mm Hg. The value of φ_{min} increased slightly on improving the vacuum (from 1.53 eV at 10^{-8} to 1.64 eV at 2×10^{-9} mm Hg); however, the difference in the work functions $\Delta\varphi = \varphi_{pl} - \varphi_{min}$ remained almost constant (around 0.25 eV). The adsorption of cesium on the field-"loosened" tungsten surface led to the development of a deeper minimum than that corresponding to a surface smoothed by heating. There was also a preferential adsorption of cesium on the dislocations emerging from the tungsten surface. (auth)

13456 ANISOTROPIC PRESSURE DEPENDENCE OF CONDUCTION IN PYROLYTIC GRAPHITE. Howell, J. A.; Yeoman, M. L.; Young, D. A. (Imperial Coll. of Science and Tech., London). pp 27-30 of Third Conference on Industrial Carbons and Graphite. London; Society of Chemical Industry (1971).

From third international conference on industrial carbon and graphite; London, England (14 Apr 1970). See CONF-700407.

It is argued that the dominant carrier scattering processes in graphite have not been correctly identified by previous workers. Thus, in order to understand the anisotropic pressure dependence of conduction in well-oriented pyrolytic graphite as a function of temperature, it is necessary to propose a dominant role for carrier–carrier scattering, at least within the basal plane. A simple mathematical model developed on this basis is used to calculate certain verifiable parameters such as textural mean free paths. Hitherto disquieting features of c-axis conduction become thereby susceptible to explanation. Experimental work was carried out on a well oriented pyrolytic graphite of good quality, before and after neutron irradiation, and on a less good graphite. (auth)

13457 PARAMAGNETIC RESONANCE OF TETRAVALENT ^{237}Np IN SINGLE CRYSTALS OF ThO_2. Richardson, Riley P.; Gruber, John B. (Washington State Univ., Pullman). J. Chem. Phys.; 56: No. 1, 256-60(1 Jan 1972).

The electron paramagnetic resonance spectrum of Np^{4+}-237 (nuclear spin, $I = 5/2$) in single crystals of ThO_2 was investigated at 1.7 and 4.2°K in the 24- and 34-GHz bands, respectively. Studies were carried out on both unstrained and strained crystals. For unstrained crystals, the ground electronic state of Np^{4+}-237 in cubic sites in ThO_2 was found to be a Γ_8 quartet in accordance with the predictions of Lea, Leask, and Wolf and could be explained in terms of Bleaney's Γ_8 spin Hamiltonian for $I = 5/2$ and $S = 3/2$. The Lea, Leask, and Wolf parameter χ, relating the crystal field splitting parameters of the cubic field, was found to be $\chi = -0.61$ for the unstrained samples. The spectrum of the strained crystals clearly showed the degeneracy of the Γ_8 state had been lifted. The zero-field splittings were estimated to be between 5 and 20 cm^{-1} in order to be consistent with both EPR and optical data, respectively. A partial analysis of the spectrum of Np^{4+}-237 in the strained crystals was carried out and could be explained using a simpler spin Hamiltonian with $I = 5/2$ and $S = 1/2$. Considerable hyperfine splitting due to the nuclear spin of neptunium-237 ($I = 5/2$) was observed. (auth)

Moessbauer Effects and NMR

13458 (IS-T-485) NUCLEAR MAGNETIC RESONANCE STUDY OF THE ANTIFERROMAGNETIC TRANSITION IN MIXED VANADIUM–CHROMIUM DIBORIDES. Schoenberger, Richard Joseph (Ames Lab., Iowa). Nov 1971. Contract W-7405-eng-82. 102p. Dep. NTIS.

Thesis.

Nuclear magnetic resonance (NMR) experiments were performed on samples of the dilute-vanadium $V_xCr_{1-x}B_2$ system to determine the nature of the transition in them. The observations of the ^{11}B and ^{51}V NMR spectra were supplemented by x-ray analysis and magnetic susceptibility measurements. It is concluded that the transition is from a paramagnetic to a magnetically ordered state. Although the system shows the presence of localized moments, the ordered state appears to involve itinerant rather than localized moments and is believed to be antiferromagnetic by analogy to the dilute-vanadium V–Cr alloy system. Two classes of samples prepared by different methods were studied. The difference in sample preparation was found to have a great effect on certain of the physical properties of the products. (auth)

13459 (IS-T-501) HIGH-FREQUENCY NUCLEAR MAGNETIC RESONANCE IN THULIUM INTERMETALLIC COMPOUNDS. Smith, William Conrad (Ames Lab., Iowa). Nov 1971. Contract W-7405-eng-82. 177p. Dep. NTIS.

Thesis.

The NMR frequency shifts of the ^{169}Tm nucleus in the NaCl-type intermetallic compounds TmP, TmAs, TmSb, and TmBi were measured at 4.2°K over a wide range of applied magnetic field strengths. The shifts for TmAs and TmBi were found to be field-independent for field strengths below 3.5 kOe, but a relatively strong field dependence was measured for TmP. In the case of TmP, measurements were extended beyond 6.5 kOe, corresponding to a resonance frequency of almost 180 MHz. The

shifts were observed to increase with applied magnetic field strength. The shift values for TmP and TmAs at low fields agreed well with previously reported values, but agreement was not good for TmSb. The shift value for TmBi, not previously reported, was measured to be 79.9(2). This value of the shift for TmBi was based on the ^{169}Tm gyromagnetic ratio of 0.352 kHz/Oe. The peak-to-peak line width of the ^{169}Tm resonance derivative was directly proportional to the applied field, with the proportionality essentially accounted for by the bulk demagnetizing field within a magnetic powder sample, except in the case of TmBi. The extrapolated zero-field line widths were roughly five times the calculated nuclear dipolar widths. In addition, the magnetic field dependence of the ^{31}P resonance line width in the TmP sample was found to be essentially the same as that of ^{169}Tm in the same sample; this finding supports the conclusion that the bulk sample demagnetization dominates the field dependence of the line width in these samples. A brief study of impurities in TmSb samples showed that the field dependence of the line width was greatly increased by sample impurities, but the resonance shift in these samples was essentially unaffected by impurity content. A search was made at 4.2°K for ^{141}Pr and ^{169}Tm resonances in a number of other intermetallic compounds and alloys. No resonance was detected in $TmSn_3$, $TmRh_2$, or $TmAl_2$, but a very weak resonance was observed in $TmNi_2$. None of a series of Pr–Th alloys of composition Pr_xTh_{1-x} (x = 0.5, 0.25, 0.1, or 0.05) yielded a detectable resonance. Similarly, no resonance was observed in a Pr–Y alloy of composition $Pr_{0.4}Y_{0.6}$. An alloy, $Tm_{0.25}Th_{0.75}$, gave no resonance, but an intense, broad, anisotropic thulium resonance was observed in the alloy, $Tm_{0.25}Sc_{0.75}$. Finally, no resonance could be identified in $Tm_{0.04}Ag_{0.96}$. (auth)

13460 NUCLEAR SPIN–LATTICE RELAXATION IN SCANDIUM–RARE EARTH ALLOYS. Fradin, F. Y. (Argonne National Lab., Ill.). Phys. Rev., B; 5: No. 3, 1119-26(1 Feb 1972).

Scandium-base alloys of between 0.02 and 5.0 at.% cerium, gadolinium, and dysprosium were studied using transient nuclear-magnetic-resonance techniques. The effect of the rare-earth solutes on the ^{45}Sc linewidth and spin–lattice relaxation rate indicates that there are localized magnetic moments associated with gadolinium and dysprosium but not associated with cerium. For gadolinium and dysprosium concentrations less than 0.1 at. %, the linewidth is linear in the magnetization and described by the Ruderman–Kittel–Kasuya–Yosida predictions. For these alloys, the spin–lattice relaxation rate is described by $1/T_1 = (1/T_1)_{Sc}[1 + KB_J(X)/H]$, where $(1/T_1)_{Sc}$ is the pure-scandium relaxation rate, K is a constant, and $B_J(X)$ is the Brillouin function of $X = g_J\mu_B H/(k_B T)$. The T_1 results are explained in terms of enhanced nuclear relaxation due to virtual excitation of the rare-earth moments. The linewidth, relaxation rate, and paramagnetic-moment enhancement for the dilute ScGd and ScDy alloys are consistent with a ratio for the effective s–f interaction constants of $(J_{sf})_{Gd}/(J_{sf})_{Dy} = 0.6 \pm 0.2$. By comparison with the ^{45}Sc results for the quadrivalent solutes titanium and thorium, it is found that cerium behaves as a quadrivalent solute in scandium. (auth)

13461 STARK SHIFT OF NUCLEAR SPIN LEVELS OF ^{9}Be IN BERYLLIUM OXIDE. Thorland, R. H.; Garrison, A. K.; DuVarney, R. C. (Emory Univ., Atlanta). Phys. Rev., B; 5: No. 3, 784-8(1 Feb 1972).

Measurements of the angular variation of the quadrupole splitting in the NMR spectrum of ^{9}Be in single-crystal BeO are reported and give $e^2qQ/h = 39.4 \pm 0.2$ kHz. The dependence of the field-gradient parameter q on an applied external electric field was investigated and interpreted, using the phenomenological relation of the form $e(\Delta q)_{ij} = \Sigma R_{ijk}E_k + \Sigma\Sigma T_{ijlm}e_{lm}$, where the first term represents the constant-strain electric-field-induced change and the second term represents the piezoelectric contribution. The strain-induced part of Δq is measured separately and found to be negligible compared to the part due directly to the electric field. An experimental value for R_{zzz} of $\pm(1.3 \pm 0.5) \times 10^9$ cm^{-1} is reported. Calculations of R_{zzz} on the basis of ionic and covalent models of the BeO structure give -4.1×10^8 and -8.2×10^8 cm^{-1}, respectively, for the ionic and covalent contributions and a total calculated R_{zzz} of -1.2×10^9 cm^{-1}. It is thus unlikely that the ionic model can account for the observed Stark shift. A determination of the crystal c axis was made using the pyroelectric effect and this, together with the Stark-shift data, indicates that the sign of the field gradient is positive. (auth)

13462 DISTRIBUTION OF MAGNETIC MOMENT IN METALLIC GADOLINIUM. Moon, R. M.; Koehler, W. C.; Cable, J. W.; Child, H. R. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 5: No. 3, 997-1016(1 Feb 1972).

Neutron-diffraction experiments with both polarized and unpolarized neutrons were carried out on single-crystal specimens of ^{160}Gd in order to measure the magnetic-moment distribution in the metal. Data were obtained in the ferromagnetic state at 96°K for all (hk0) reflections out to $(\sin\theta)/\lambda = 1.275$ and nearly all (0kl) peaks to $(\sin\theta)/\lambda = 1.04$. Measurements were made as well at a temperature above the Curie point. The shape of the spin distribution appears to be identical at the elevated temperature (313°K) to that observed at 96°K. The form-factor data can logically be separated into diffuse and localized components, which may be identified with the conduction electrons and 4f electrons, respectively. The 4f density is spherically symmetric, and it has a radial dependence that is significantly expanded relative to Hartree–Fock wave functions for the free trivalent ion. Good agreement can be achieved with theoretical form factors based on relativistic Hartree–Fock–Slater wave functions. The diffuse density does not have the distribution expected for 5d or 6s orbitals. It is long-range and oscillatory, however, as one expects for conduction electrons in the rare earths. Measurements of the form factor of Gd^{+3} in paramagnetic Gd_2O_3 were also made, and the results are in excellent agreement with the free-ion calculations, except at very small scattering angles. (auth)

13463 NUCLEAR MAGNETIC RESONANCE OF β-ACTIVE ^{8}Li NUCLEI PRODUCED BY POLARIZED NEUTRON CAPTURE IN LiF SINGLE CRYSTALS. Bulgakov, M. I.; Gul'ko, A. D.; Oratovskii, Yu. A.; Trostin, S. S. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 2, 667-77(Aug 1971). (In Russian).

The NMR line shape for polarized β-active ^{8}Li nuclei, produced by capture of polarized thermal neutrons, was measured at room temperature. Three single-crystal LiF samples with their (100), (110), and (111) planes directed perpendicular to the magnetic field and two powder samples of LiF and ^{7}LiF (with a lower ^{6}Li content) were studied. The line shape was investigated by observing the destruction of angular anisotropy of the β radiation from polarized ^{8}Li nuclei induced by a magnetic radio-frequency field H_1. A theoretical calculation of the line shape is carried out under the assumption of dipole–dipole interaction for a rigid lattice. The second moments of the line shape are calculated. A comparison with the experiments shows that the internal local fields in ^{8}Li nuclei possess a Gaussian distribution with a deviation toward a Lorentz form occurring only at the wings ($\sim 10^{-2}$ of the peak value). No significant effect of lattice imperfections due to γ recoil of ^{8}Li nuclei on the shape of the resonance lines was observed. (auth)

13464 INTERFERENCE OF PHOTOELECTRIC AND NUCLEAR RESONANCE ABSORPTION OF 26 keV E1 γ-RAYS IN ^{161}Dy STUDIED BY TRANSMISSION AND SCATTERING MOESSBAUER EXPERIMENTS. Steiner, P.; Weyer, G. (Freie Univ., Berlin). Z. Phys.; 248: No. 4, 362-9(1971).

The interference of photoeffect and internal conversion following nuclear-resonance absorption of 26-keV E1 γ quanta in ^{161}Dy was measured in Moessbauer transmission experiments and by direct detection of re-emitted conversion electrons in a parallel-plate avalanche counter. The ratio of the amplitudes of the interference terms in transmission and scattering experiments was found to be in agreement with the theory. An angular distribution of the interference effect was observed in the scattering experiments. (auth)

13465 EFFECT OF ELECTRON ACOUSTIC RESONANCE ON THE SHAPE OF THE MOESSBAUER SPECTRUM. Bashkirov, Sh. Sh.; Galeeva, N. M.; Gol'danskii, V. I.; Sadykov, E. K. (Inst. of Chemical Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 6, 1482-5(Dec 1971).

Translated from Fiz. Tverd. Tela; 13: No. 6, 1775-8(Jun 1971).

The change in the shape of the Moessbauer spectrum that may be produced by the acoustic resonance on the electron levels of a paramagnetic ion is studied. The special feature of such experiments is that the probability of acoustic resonance transitions is determined by the acoustic intensity and is therefore a controllable parameter. As an example, Fe^{2+} in MgO is studied; the probabilities of acoustically induced transitions are estimated. The dependence of the line shape of the nuclear gamma resonance on the intensity of the sound is determined from these calculations. The experimental realization of the discussed effect is complicated by the difficulties peculiar to ultrasonic experiments. An experimental system based on γ-ray scattering is suggested. Similar experiments may be useful for studying the dynamics of the electron shell of a paramagnetic ion. Thus, in particular, the electron acoustic resonance may be detected. (auth)

13466 NUCLEAR MAGNETIC RESONANCE AND RELAXATION OF ^{159}Tb IN FERROMAGNETIC TERBIUM METAL. Sano, Naokatsu; Itoh, Junkichi (Osaka Univ.). J. Phys. Soc. Jap.; 32: No. 1, 95-103(Jan 1972).

Nuclear magnetic resonance and relaxation of ^{159}Tb in ferromagnetic Tb metal were investigated by the spin-echo technique at liquid-helium temperatures. The nuclear magnetic resonance spectrum consists of three equally separated lines in the frequency range from 2.4 to 3.9 GHz. The center-line frequency, which corresponds to the Zeeman frequency, is 3120 MHz and the frequency difference of the adjacent lines, which represents the electric quadrupole effect, is 673.5 MHz. It is found that spin–lattice relaxation is produced mainly by the process in which the nuclear energy relaxes to the kinetic energy of the conduction electrons via spin waves (Weger's mechanism), as in the case of Dy nuclei in ferromagnetic Dy metal, and the spin–spin relaxation time is determined by the spin–lattice relaxation and the $I \cdot I$ coupling. (auth)

Theory

13467 SPIN–ROTATION INVARIANCE AND THE STRUCTURE OF CORRELATION FUNCTIONS IN MAGNETIC SYSTEMS. Corrias, M. (Consiglio Nazionale delle Ricerche, Turin); de Pasquale, F. J. Low Temp. Phys.; 5: No. 6, 651-63(Dec 1971).

In the framework of the functional approach to statistical mechanics, general properties of correlation functions in ordered magnetic systems are analyzed. The aim is to investigate what consequences can be derived from the requirement of invariance of the theory under local infinitesimal spin rotation. The extension of the method that is introduced, to include anisotropic Hamiltonians, is discussed, and the case of the anisotropy described by an internal field is worked out. The main results are a set of generalized Ward identities, a microscopic definition of the stiffness constant as a static limit of a local response function, and an exact asymptotic expression for the correlation functions of interest, for zero temperature and small wave length and frequency. Modifications to the hydrodynamic expression for correlation functions in the case where anisotropy is present are also discussed. (auth)

13468 STABILITY OF THE ELECTRONIC CONFIGURATION IN METALS AT HIGH PRESSURES: THE RARE EARTHS. Royce, E. B. Rend. Scu. Int. Fis. Enrico Fermi; 48: 95-106 (1971).

In previous lectures the determination of a high-pressure equation of state from the use of shock-wave techniques and theoretical models has been discussed. Methods have been outlined for experimentally determining a Hugoniot and for calculating a cold-compression curve and cohesive-energy curve from this Hugoniot. These curves are the results that are most easily related to ordinary solid-state concepts, since they are independent of thermal effects, depending only on the static interatomic interaction. These curves are analyzed in terms of a rather primitive theory of binding in metals in order to infer some information regarding electronic configurations in compressed metals. (W.D.M.)

Theoretical Physics

Refer also to abstracts 13734, 13760–13764, and 14248.

13469 (INR–1333) CLASSICAL SCATTERING OF RADIATION BY AN OSCILLATING ELECTRON. Zakowicz, Wladyslaw (Institute of Nuclear Research, Warsaw (Poland)). 1971. 4p. Dep. NTIS (U. S. Sales Only).

It is shown that classically described scattering of light by an oscillating electron leads to a spectrum consisting of many stokes and antistokes lines. For this scattering, formulas for nth-order correlation functions are given. It appears that this process can be interpreted as phase modulation of radiation. (auth)

13470 THEORY OF EXTENDED QUANTISATION. Crocker, Roger (John Carroll Univ., Cleveland). Int. J. Theor. Phys.; 3: No. 4, 283-7(Aug 1970).

A new theory of quantization is presented. After arguments are given indicating that mass–energy in the Universe is quantized, this quantization is mathematically related to the lifespan and maximum size of the Universe. Various consequences are then deduced, such as the existence of a minimum force. (auth)

13471 CLASSICAL LIMIT OF QUANTUM MECHANICS. Andrie, M. (Univ., Bonn). Commentat. Phys.-Math.; 41: 333-49(Dec 1971). (In German).

The classical limit of quantum mechanics characterized by $h \to 0$ (h Planck's constant) is based on a rigorous mathematical proof. It is shown that under certain conditions the solution of the Schroedinger equation of a quantum-mechanical problem defines a density, which in the limit $h \to 0$, is correlated with a δ-distribution, the carrier space of which is exactly a definite classical orbit. The expectation value of a self-adjoint operator approaches the corresponding classical observable. The proposed construction essentially uses the theory of complete solutions of a Hamilton–Jacobi equation. (auth) (Finland)

13472 ENERGY–MOMENTUM QUANTA IN FRESNEL'S EVANESCENT WAVE. Costa de Beauregard, O. (Institut Henri Poincare, Paris); Imbert, Ch.; Ricard, J. Int. J. Theor. Phys.; 4: No. 2, 125-40(Apr 1971).

Fresnel's theory of the evanescent wave in total reflection requires that the propagation vector k and the momentum quanta $\hbar k$ have an imaginary component and, thus, a projection on the reflecting plane that is larger (in units such that $c = 1$) than the angular frequency ω and the energy quanta $\hbar\omega$. The "tachyon properties" of these energy–momentum quanta are discussed, and an experimental test using absorption or stimulated emission by an atomic or ionic beam is proposed. It is then shown that the Maxwell–Minkowski tensor (although certainly appropriate to discuss the macroscopic energy–momentum exchange between wave and diopter) does not describe adequately the energy–momentum density of the quanta in the evanescent wave, this stemming from its too-remote connection with the generator ∂_i of space–time displacements. On the other hand, de Broglie's energy–momentum tensor $A_k[\partial^l]\, B^{jk}$ is the density canonically associated with the generator of space–time displacements; it is shown that it describes quite satisfactorily both the energy fluxes (as measured through the longitudinal Goos–Hänchen and the new transverse shifts of the reflected beam in total reflection) and the momentum densities of the quanta inside the evanescent wave. Finally, it is shown that it is the gauge that is transverse in the diopter's rest frame that directly yields the physically measured energy fluxes. This fact is taken as a new argument, strongly supported by experimental evidence, in favor of the physical reality of electromagnetic potentials. (auth)

13473 PARADOX OF RADIATION FROM A UNIFORMLY ACCELERATED POINT ELECTRON AND A CONSISTENT PHYSICAL FRAMEWORK FOR ITS RESOLUTION. Leiter, Darryl (Univ. of Windsor, Ont.). Int. J. Theor. Phys.; 3: No. 5, 387-93(Oct 1970).

The problem of an electron in an external, uniform electric field is studied. The problem is analyzed within the framework of a new theory of Maxwell electrodynamics in which the problems and paradoxes of infinite self-energies are omitted by considering only the interactions between charged particles as the basic building blocks of the theory. For this case of uniform acceleration, the manifest consistency and physical transparency of this new electrodynamic formalism allows a simple and physically clear interpretation to be ascribed to the "acceleration energy" and the role it plays in acting as the source of energy radiated from the accelerated charge. The relationship of the acceleration energy to the internal energy of the electron is clarified in terms of the "total coupled radiation field" of the system. At the same time, the new formulation of electrodynamics is shown to represent a completely consistent theory of a classical electron in an external field, which in many aspects is a superior alternative to either Maxwell–Lorentz theory or Wheeler–Feynman theory. (auth)

13474 ENERGY LOSS IN CHERENKOV RADIATION. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Indian J. Phys.; 44: No. 6, 346-9(Jun 1970).

It is shown that the electromagnetic-field energy associated with a charged particle moving with uniform velocity since an infinite remote past in an infinitely extended homogeneous medium is constant. The usual expression for the rate of loss of energy of a particle calculated from the total Poynting flux is shown to be negative of the volume integral of $cE \cdot j$. (auth)

13475 NONADIABATIC CHARGED-PARTICLE MOTION NEAR A MAGNETIC FIELD ZERO LINE. Rusbridge, M. G. (Univ. of Manchester, Eng.). Plasma Phys.; 13: No. 10, 977-87(Oct 1971).

It is known that the adiabatic invariance of the magnetic moment of a charged particle breaks down when the particle passes near a field zero. The extreme case of this breakdown, arising when the particle orbit encloses the field zero, is investigated by computation of particle orbits. It is found that the magnetic moment changes by a factor with a maximum value of about 5.75; the exact value depends on the phase of the particle in its orbit, and the details of the dependence are explained on a simple model. (auth)

13476 EFFECT OF A SHIELD ON RADIATION FROM A CHARGE MOVING PARALLEL TO A DIELECTRIC SLAB. Naryshkina, L. G.; Yurkov, I. M. (Moscow State Pedagogical Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 867-71 (Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1096-1102(Jun 1971).

The Cherenkov radiation from a charged particle moving parallel to a dielectric slab is investigated. A comparison is made with the case of a dielectric slab bounded on one side by a perfectly conducting shield. The radiation spectrum is studied. (auth)

13477 NONLINEAR THEORY OF THE CONTROL OF A MODULATED BEAM OF CHARGED PARTICLES BY CHERENKOV RADIATION. Tolstoluzhskii, A. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 877-81(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1109-14(Jun 1971).

The nonlinear theory of the control of a modulated beam passing through a slow wave resonator is discussed. Control is achieved by changing the modulation frequency of the beam. It is shown that a programmed change in the modulation frequency of the beam can reduce the reaction of the self-field on the motion of the beam particles, thereby increasing the maximum field amplitude. The maximum amplitude and phase of the field is found in the limiting cases of relativistic and nonrelativistic beams. (auth)

13478 PHOTON SPLITTING AND PHOTON DISPERSION IN A STRONG MAGNETIC FIELD. Adler, Stephen L. (Inst. for Advanced Study, Princeton, N. J.). Ann. Phys. (N.Y.); 67: No. 2, 599-647(Oct 1971).

The refractive indices for photon propagation and the absorption coefficient and polarization selection rules for photon splitting in a strong constant magnetic field are determined. Results are presented, both in the effective Lagrangian (low-frequency) approximation and in a more accurate approximation that exactly sums the vacuum polarization ring diagrams, neglecting only internal virtual photon radiative corrections. The principal conclusion is that photon splitting can provide a mechanism for the production of linearly polarized gamma rays. (auth)

13479 PATH INTEGRALS AND SEMICLASSICAL TUNNELING, WAVE FUNCTIONS, AND ENERGIES. Freed, Karl F. (Univ. of Chicago). J. Chem. Phys.; 56: No. 2, 692-7(15 Jan 1972).

The semiclassical limit of Feynman path integrals is investigated in order to determine those classical trajectories that contribute to tunneling processes. The semiclassical bound-state energies, wave functions, and scattering phase shifts are directly recovered from the poles and residues of the semiclassical Green's function in energy space. Some extensions to cases of tunneling and bound states for multidimensional nonseparable potentials are discussed. (auth)

13480 EXAMPLE RELATED TO THE FOUNDATIONS OF QUANTUM THEORY. Davies, E. B. (St. John's Coll., Oxford). J. Math. Phys. (N. Y.); 13: No. 1, 39-41(Jan 1972).

A very simple example of a statistical system is constructed that satisfies almost all of the axioms used by various authors in the quantum-logic approach to the foundations of quantum mechanics. Since the example is not quantum-mechanical, it is seen that present arguments are a long way from characterizing quantum mechanics in terms of a set of physically meaningful axioms. (auth)

13481 ANALYTICITY AND QUANTIZATION. Onofri, E.; Pauri, M. (Univ., Parma, Italy. Istituto Nazionale di Fisica Nucleare, Milan). Lett. Nuovo Cim.; 3: No. 1, 35-42(1 Jan 1972).

It is noted that previous work on canonical quantization does not provide a solution of the full Dirac problem for the Euclidean case. For this reason a new approach was previously proposed which amounts to a reformulation of the full Dirac problem and renders the quantization a system-dependent procedure. The features of dynamical quantization were evidenced by studying the n-dimensional harmonic isotropic oscillator and the n-dimensional hydrogen atom. New results are given which substantially improve this approach. The basic conceptual point is the explicit recognition of the role that analyticity plays in the abstract process of quantization. The general reformulation of the theory is given in detail, and for the example of the harmonic oscillator the result of Streater is generalized. (J.F.P.)

13482 PERTURBATION METHOD FOR THE ONE-DIMENSIONAL SCHROEDINGER EQUATIONS, VALID IN THE REGION WHERE THE WAVE-FUNCTION IS SMALL. Pekar, V. S. (Inst. of Semiconductors, Kiev). Teor. Mat. Fiz.; 9: No. 3, 440-4(Dec 1971). (In Russian).

The usual perturbation theory series converges badly in the region where the wave function ψ is small and the relative correction to ψ is great. A new simple perturbation method is proposed, which is valid, in particular, in the region where ψ is small. The method is based on expanding in the perturbation theory series not the function ψ itself, but its logarithmic derivative, $d/d_x \ln\psi$. Corrections of any order to eigenfunctions and eigenvalues are expressed in quadratures instead of infinite series. Examples are considered that demonstrate the rapid convergence of the method proposed in cases when the series of the usual theory converges badly. (auth)

13483 WEAK CONVERGENCE IN THE INFINITE TENSOR PRODUCT OF HILBERT SPACES. Burban, I. M. (Inst. of Theoretical Physics, Kiev). Teor. Mat. Fiz.; 9: No. 3, 318-22 (Dec 1971). (In Russian).

Investigation was made of weakly convergent operator series in the incomplete infinite tensor product of Hilbert spaces. It is proved that in the case when the dense domain exists, on which the sequences of partial sums of positive operators converge, weakly, the limit operator is essentially self-adjoint. (auth)

13484 MAGNETIZATION OF HARMONICALLY BOUND CHARGES. Papadopoulos, G. J. (Univ. of Leeds, Eng.). J. Phys., A (London); 4: No. 6, 773-81(Nov 1971).

The propagator for a harmonically bound charged particle in a constant uniform magnetic field is evaluated exactly, from which the corresponding partition function and density of states are obtained. Then, the equilibrium response of an assembly of harmonically bound point charges is studied using both Boltzmann and Fermi–Dirac statistics. The results are considered in relation to the ionic lattice and to some extent to the charged nucleons. (auth)

13485 EVOLUTION OF A RELATIVISTIC HEAT CONDUCTING FLUID USING THE ECKART SCHEME. Mahjoub, Bechir (Univ., Tunis). Ann. Inst. Henri Poincare, Sect. A; 15: No. 2, 153-68(1971). (In French).

The evolution system (S) of a relativistic heat conducting fluid, described by an Eckart's type energy tensor, is established, and its various characteristic forms are determined. It is demonstrated that under certain hypotheses the (S) system is not strictly hyperbolic and a unique solution with a Gevrey class index $\alpha = 7/6$, is possible; such a solution is physically equivalent to a non-strictly hyperbolic system having a Gevrey class index $\alpha' = 2$. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 13843.

13486 SCIENCE, PHYSICS, AND PARTICLE PHYSICS. Shutt, R. P. (Brookhaven National Lab., Upton, N. Y.). pp 1-48 of Elementary Particles. Science, Technology, and Society. /Yuan, Luke C. L. (ed.). New York; Academic Press Inc. (1971).

The role of science, physics, and particle physics among human efforts is examined. The aims and methods of high-energy physics are stated, and the value of this field in attaining short- and long-range human goals is discussed. (J.F.P.)

13487 HIGH-ENERGY INTERACTIONS IN SPACE. Kirsten, Till A.; Schaeffer, Oliver A. (State Univ. of New York, Stony Brook). Contract AT(30-1)3629. pp 75-157 of Elementary Particles. Science, Technology, and Society. /Yuan, Luke C. L. (ed.). New York; Academic Press Inc. (1971).

A summary is given of thin- and thick-target cross section measurements. This information is related to cosmic ray variations in time and space, energy spectrum in the past, and composition. Also the terrestrial age, space erosion, and exposure ages of meteorites, cosmic dust, the lunar surface, and tektites are discussed relative to the cross section measurements. (J.F.P.)

Electromagnetic

Refer also to abstracts 12142, 13628, 13860, and 13881.

13488 (JINR-P1-6212) EXPERIMENTS ON THE ELECTROMAGNETIC INTERACTION PHYSICS USING THE LIQUID-HYDROGEN CHAMBER "LUDMILA." Baldin, A. M.; Viryasov, N. M.; Govorkov, B. B.; Gramenitskii, I. M.; Lebedev, A. I.; Samoilov, A. V.; Sapunov, Yu. M.; Frolov, A. M.; Tsarev, V. A.; Shafranov, M. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 40p. (In Russian). Dep. NTIS (U. S. Sales Only).

A positron beam is suggested to be used for production of the photon beam of energy up to 35 GeV which can be used in irradiating the "Ludmila" chamber. Investigation of interactions allows the research on the vector meson production and on the inclusive reactions to be carried out. Use of polarized photons makes it possible to perform checking of various theoretical models and to obtain some physical results in the region of energies unattainable, at present, for other accelerators. (auth)

13489 (LBL-500, pp 219-22) POLARIZED PROTON TARGET EXPERIMENT TO TEST TIME REVERSAL INVARIANCE. Nefkens, B. M. K. (California Univ., Los Angeles). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

A measurement of left-right asymmetry in the reaction $\pi^- p \rightarrow \gamma n$ from a polarized proton target, in conjunction with a measurement of the recoil proton polarization in $\gamma n \rightarrow \pi^- p$, is a good test of time-reversal invariance in the electromagnetic interaction of hadrons. (auth)

13490 (LNF-71/62) HADRON PRODUCTION BY e^+e^- COLLIDING BEAMS IN THE GeV REGION (2E = 1.4 TO 2.4 GeV). Borgia, B.; Conversi, M.; Grilli, M.; (and others) (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 20 Sep 1971. 13p. (CONF-710816-5). Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug. 1971).

The production of hadrons in e^+e^- collisions at a total energy of 1.4 to 2.0 GeV was studied using the Frascati storage ring Adone. The most interesting of the results on $e^+ + e^- \rightarrow \pi^+ + \pi^-$ interactions are the energy dependence of the pion pair cross section and the small ratio between kaon and pion pairs. Cross sections were also found for $e^+ + e^- \rightarrow 2\pi^+ + 2\pi^-$, $e^+ + e^- \rightarrow 2\pi^+ + 2\pi^- + 2\pi^0$, and $e^+ + e^- \rightarrow A_1 + \pi$ interactions. (J.F.P.)

13491 (LNF-71/63) RESULTS ON e^+e^- REACTIONS AT ADONE (1.4 TO 2.4 GeV). Bernardini, C. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 23 Sep 1971. 17p. (CONF-710816-4). Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

A survey of results from experiments on $e^+ + e^-$ interactions is presented. These experiments cover tests of quantum electrodynamics, two-photon reactions, production of proton-antiproton pairs, and reactions with more than two final particles at wide angles. (J.F.P.)

13492 (TID-25874, pp 1-11) ELECTROMAGNETIC EXPERIMENTS AT NAL. Morrison, R. J. (California Univ., Santa Barbara); Engels, E. Jr.; Goitein, M.; Paschos, E. A.; Patel, P.; Pipkin, F. M.; Tannenbaum, M.; Tenenbaum, J.; Trefil, J. S.; Yount, D. 1970.

In 1970 summer study.

A number of possibilities for studying electromagnetic interactions at NAL are considered. In this report the scope of these studies is given, and some of the proposed experiments are discussed. Other experiments as well as questions concerning the electron-photon beam are considered in accompanying reports. (auth)

13493 (TID-25874, pp 13-17) SOME COMMENTS CONCERNING ELASTIC PION-ELECTRON AND KAON-ELECTRON SCATTERING AT NAL. Engels, E. Jr. (Pittsburgh Univ., Pa.). 1970.

In 1970 summer study.

It has been proposed that the electromagnetic radius of the pion can be measured to an accuracy of 0.03 F at NAL energies (NAL Proposals 49 and 71). A simultaneous measurement of the kaon radius to an accuracy of 0.07 F is suggested. (auth)

13494 (TID-25874, pp 23-5) MULTIBODY PHOTOPRODUCTION AT NAL. Yount, D. (Hawaii Univ., Honolulu). 1970.

In 1970 summer study.

The possibility of performing multibody photoproduction experiments at NAL is reviewed. (auth)

13495 (TID-25874, pp 197-204) MUON EXPERIMENTS. Goitein, M. (California Univ., [Livermore]. Lawrence Radiation Lab.); Tenenbaum, J. (Stanford Linear Accelerator Center, Calif.). 1970.

In 1970 summer study.

The proposals concerning muon experiments are discussed. The emphasis is on inelastic form factors, muon anomalies (tridents, etc.), detection of hadronic final states for high-q^2 events, and a check of scale invariance. General beam and apparatus requirements are listed. (R.W.R.)

13496 (TID-25874, pp 245-8) TWO COMMENTS CONCERNING π-e ELASTIC SCATTERING (PROPOSALS 49 AND 71). Goitein, Michael (California Univ., [Livermore]. Lawrence Radiation Lab.). 1970.

In 1970 summer study.

A calculation of knock-on probabilities indicates severe problems in surrounding a long target with veto counters more forward than about 25°. This question is relevant to all experiments with veto counters. A second comment suggests that shower counters be used in both the electron and π^- detectors of Proposal 71. (auth)

13497 (TID-25874, pp 397-405) QUARK AND MONOPOLE SEARCHES AT NAL. Carrigan, R.; Yamanouchi, T. (National Accelerator Lab., [Batavia], Ill.); Derenzo, S. (California Univ., [Livermore]. Lawrence Radiation Lab.); Frankel, S. (Pennsylvania Univ., Philadelphia); Lee, W. Y. (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.); Mischke, R. E. (Princeton Univ., N. J.); Trefil, J. S. (Illinois Univ., Urbana). 1970.

In 1970 summer study.

The general field of quarks and monopole searches at NAL is discussed; facilities which should be provided are recommended, and priorities to be given to various types of experiments are suggested. (auth)

13498 PHOTOPRODUCTION OF NEUTRAL ρ MESONS. McClellan, G.; Mistry, N.; Mostek, P.; (and others) (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 4: No. 9, 2683-93(1 Nov 1971).

Results are presented on a series of measurements of ρ-photoproduction from hydrogen, deuterium, and complex nuclei ranging up to lead, at photon energies ranging from 4 to 9 GeV. Detailed dipion mass-spectrum fits are presented, using a Drell-type nonresonant background and its interference with the resonant amplitude, with no other arbitrary backgrounds. For hydrogen and deuterium, the inelastic contributions were subtracted. The A dependence of the cross sections is analyzed to yield values of $\gamma_0^2/4\pi$ and $\sigma_{\rho N}$ at average photon energies of 6.1, 6.5, and 8.8 GeV. The hydrogen-to-deuterium ratios indicate the presence of possible nondiffractive amplitudes at low energies which then decrease with energy. (auth)

13499 TEST OF THE $\Delta S = \Delta Q$ RULE IN $K_{\ell 3}^0$ DECAYS. Ling, Ta-yung. Madison, Wis.; Univ. of Wisconsin (1971). 82p. University Microfilms Order No. 71-23,314.

Thesis.

A heavy liquid bubble chamber experiment was conducted to test the validity of the $\Delta S = \Delta Q$ rule. Initially pure K^0 states were produced by charge exchange reaction of 850 MeV/c K^+'s in light freon. The time distribution of 287 $\pi^\mp e^\pm \nu$ decays from the neutral kaon state was analyzed by the maximum likelihood method to determine the best estimate of the complex number x, defined as the ratio of $\Delta S = -\Delta Q$ amplitude to the $\Delta S = \Delta Q$ amplitude. It was found that $Re(x) = 0.11 \pm 0.07$; $Im(x) = 0.04 \pm 0.09$, a result consistent with no violation of the $\Delta S = \Delta Q$ rule. (Diss. Abstr. Int., B)

13500 REACTION $\gamma p \rightarrow \rho^0 p$ AT 5.5 TO 18 GeV. Park, J.; Davier, M.; Derado, I.; (and others) (Stanford Univ., Calif.). Nucl. Phys.; B36: No. 2, 404-18(1972).

The reaction $\gamma p \rightarrow \rho^0 p$ in the energy range $5.5 < E\gamma < 18$ GeV was studied using a streamer chamber exposed to an 18 GeV bremsstrahlung beam. The results differ from earlier counter experiments in the following ways: (i) the ρ cross section is constant ($\approx$12 μb) throughout the energy range and (ii) both $d\sigma/dt|_{t_{min}}$ and the slope parameter of $d\sigma/dt$ are constant and have significantly smaller values ($\approx$82 $\mu b/GeV^2$ and 6.6 GeV^{-2} respectively) at all of our energies. The t-dependence of the ρ density matrix in both s- and t-channel helicity frames shows that the production conserves the s-channel helicity at all t-values observed (up to -0.8 GeV^2). (auth)

13501 PRECISION MEASUREMENT OF THE MEAN LIFETIME OF THE LONG-LIVED NEUTRAL K-MESON. Vosburgh, Kirby Gannett. New Brunswick, N. J.; Rutgers-The State Univ. (1971). 97p. University Microfilms Order No. 72-887.

Thesis.

A measurement was made of the mean lifetime of the long-lived neutral K-meson. The exponential decrease in kaon intensity along a beam line was observed as a function of the particle momentum. The decaying K-mesons were detected by a scintillation counter array which was moved to different points along the beam. The momentum of each neutral kaon was determined from its measured time of flight. The mean lifetime is measured to be 51.54 ± 0.44 nanoseconds. The estimated error is dominated by a statistical error of 0.42 nanoseconds. The result is in good agreement with previous measurements, and represents an improvement of a factor of three in the estimated uncertainty compared with the best prior measurement. The result supports the conclusion that the "Delta-I = $\frac{1}{2}$ rule" predictions are not correct for the three-pion decays of the neutral and charged K-mesons. (Diss. Abstr. Int., B)

13502 SEARCH FOR THE DIRAC MONOPOLE WITH THE HIGH-ENERGY PHYSICS INSTITUTE 70-GeV PROTON SYNCHROTRON. Barkov, L. M.; Gurevich, I. I.; Zolotarev, M. S.; (and others) (Inst. of Atomic Energy, Moscow. Inst. of Nuclear Physics, Novosibirsk, USSR. Inst. of High-Energy Physics, Serpukhov, USSR). Zh. Eksp. Teor. Fiz.; 61: No. 5, 1721-36(Nov 1971). (In Russian).

A search for the Dirac monopole at the 70 GeV proton synchrotron with the employment of ferromagnetic traps is described. It was found that the upper limit of the monopole production cross section in proton-nucleon collisions was $\sigma(95\%) \leq 2{,}1(10)^{-43}$ cm^2 for $m_s \leq 5{,}15\ m_p$ and $g \geq 68{,}5$ e. (auth)

13503 DETERMINATION OF K^+-MESON ELECTROGENERATION CROSS SECTION USING THE PHOTOEMULSION METHOD. Galstyan, D. A.; Kharitonov, V. M. Yadern. Fiz.; 14: No. 4, 771-3(Oct 1971). (In Russian).

The K^+-meson electrogeneration cross section in the thin (20 mc) Cu target by the electrons of the inner beam of the 4.0-GeV Erevan electron accelerator at an angle of 60° to the electron beam is determined using the nuclear photoemulsion method. The cross section is found to be $(1.67 \pm 0.30)(10^{-34})$ $cm^2/sterad \cdot MeV/c$. The beam monitoring was made in the γ beam generated in the same target and registered by the Wilson quantometer. (auth)

13504 UPPER LIMIT OF THE ELECTRIC-DIPOLE MOMENT OF THE LAMBDA-HYPERON. Baroni, G.; Petrera, S.; Romano, G. (Instituto Nazionale di Fisica Nucleare, Rome. Univ., Rome). Lett. Nuovo Cim.; 2: No. 24, 1256-8(11 Dec 1971).

The electric dipole moment of the Λ hyperon was determined from measurements of $\pi^- + p \rightarrow \Lambda + K^0$ events at 1.05 GeV/c. The result is found to be consistent with zero, and an upper limit on its value is set at 10^{-14} e × cm. (L.B.S.)

Weak

Refer also to abstracts 13881, 13889, and 13893.

13505 (TID-25874, pp 241-3) SUMMARY OF NEUTRINO PROPOSALS. Yount, D. (Hawaii Univ., Honolulu). 1970.

In 1970 summer study.

The first eleven neutrino proposals submitted to NAL are summarized. (auth)

13506 (TID-25874, pp 255-69) THEORETICAL QUESTIONS AND MEASUREMENTS OF NEUTRINO REACTIONS IN BUBBLE CHAMBERS. Clavelli, L. (National Accelerator Lab., [Batavia], Ill.); Engelmann, R. (Argonne National Lab., Ill.). 1970.

In 1970 summer study.

Theoretical questions of interest in neutrino physics and the experimental aspects of these reactions in the NAL 15-ft bubble chamber are discussed. Reactions are discussed in order of decreasing simplicity. A table summarizes the capabilities of the 15-ft chamber with and without additional equipment. (auth)

13507 (TID-25874, pp 271-7) EFFECTS OF SHIELD LENGTH AND PROTON ENERGY ON BUBBLE-CHAMBER NEUTRINO EXPERIMENTS. Cho, Y. (Argonne National Lab., Ill.). 1970.

In 1970 summer study.

The neutrino-BC subgroup studied the questions of 200-GeV vs 500-GeV operation and the muon-shield length vs event rate. They concluded that the bubble chamber should be located at the 500-GeV area; the shield length of ~600 m will enable the bubble chamber to carry out the neutrino experiments with reasonable event rates; and, if the bubble chamber is situated at 1400–1400 configuration, it may be necessary to build a second beam of 100-GeV protons in order to gain high event rates. (auth)

13508 (TID-25874, pp 339-42) HYPERON BETA DECAYS AT NAL. Aronson, S.; Winston, R. (Chicago Univ., Ill.); Lach, J.; Roberts, A. (National Accelerator Lab., [Batavia], Ill.); Meunier, R. (European Organization for Nuclear Research, Geneva (Switzerland)); Pondrom, L. (Wisconsin Univ., [Madison]) Romanowski, T. (Argonne National Lab., Ill.). 1970.

In 1970 summer study.

Advantages of NAL energies for the study of hyperon beta decays are discussed in some detail. (auth)

13509 (TID-25874, pp 407-10) HADRONIC BRANCHING RATIO OF THE W BOSON. Clavelli, L.; Swank, J. (National Accelerator Lab., [Batavia], Ill.). 1970.

In 1970 summer study.

By using scale invariance and SU(3) × SU(3) symmetry W decay into hadrons is related to the high-energy e^+e^- annihilation into hadrons. Quark and parton models for e^+e^- annihilation are then used to estimate the branching ratio $\Gamma(W \rightarrow \text{hadrons})/\Gamma(W \rightarrow \mu\nu)$. $W \rightarrow 2\pi$ is also compared to the total hadron rate. (auth)

13510 MEASUREMENT OF THE TWO-PHOTON DECAY OF THE K^0_L MESON. Enstrom, J.; Akavia, G.; Coombes, R.; (and others) (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 9, 2629-37(1 Nov 1971).

A measurement of the rate $\Gamma(K^0_L \rightarrow 2\gamma)$ was made relative to the rates $\Gamma(K^0_L \rightarrow 3\pi^0)$, $\Gamma(K^0_L \rightarrow \pi^\pm \mu^\mp \nu_\mu)$, and $\Gamma(K^0_L \rightarrow \pi^\pm e^\mp \nu_e)$ in a spark-chamber scintillation-counter experiment. Using published branching ratios of the three-body decays relative to the rate $\Gamma(K^0_L \rightarrow \text{all})$, the branching ratio $\Gamma(K^0_L \rightarrow 2\gamma)/\Gamma(K^0_L \rightarrow \text{all})$ was found to be $(4.5 \pm 1.0) \times 10^{-4}$, based on 23 valid decays, which were separated from a small background. (auth)

13511 RELAXATION OF μ^+-MESON SPIN IN SUBSTANCES WITH SATURATED BONDS. Gurevich, I. I.; Meleshko, E. A.; Muratova, I. A.; (and others) JETP Lett. (USSR) (Engl. Transl.); 14: No. 7, 297-9(5 Oct 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 7, 436-8(5 Oct 1971).

The depolarization of positive muons in hexane, heptane, octane, and methyl alcohol is investigated. It was found that the residual polarization of the μ^+ in these substances exceeds the value $P_{res} = \frac{1}{2}$ and does not depend on the transverse magnetic field. It was found that this dependence of the residual polarization on the transverse magnetic field obeys the same laws as for many other instances. Also it was found that for these substances a lowering of the temperature to −78°C does not lead to a change of residual polarization. (J.F.P.)

Strong (Baryon-Induced)

13512 (FRNC-TH-115) INVESTIGATION OF THE $^1S_0$ NEUTRON–NEUTRON INTERACTION IN THE FINAL STATE OF THE D(n,nn)p REACTION AT 14.55 MeV. Perrin, Claude (Grenoble Univ. (France)). 1971. 78p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The sigma ($T_1\Omega_1\Omega_2$) cross section was measured for the D(n,nn)p reaction at 14.55 MeV in a geometry $\psi_1 = \psi_2$ favorable to the $^1S_0$ neutron–neutron final state interaction. A maximum cross section 8.2 ± 0.7 mb/$sterad^2$. MeV was found for $\vec{p}_1 = \vec{p}_2$. It is demonstrated that the neutron–neutron scattering parameters cannot be deduced from this measurement unless the reaction is examined without approximations or a perfect apparatus is used. The results obtained from the measurements are compared with those obtained from the distributions calculated using separable potentials to estimate the off-shell effects, considering the deu-

teron as a $^3S_1$ state, and neglecting tensor interactions. This comparison demonstrates the importance of backscattering, the effect of the nucleon–nucleon scattering parameters on the form of the distributions obtained, and the effect of the choice of the nucleon–nucleon potential on the calculated cross section. The agreement between the measured and calculated cross sections is not perfect. (France)

13513 (LBL–500, pp 341-53) NUCLEON–NUCLEON SCATTERING IN THE ENERGY REGION 300 TO 3000 MeV USING POLARIZED PROTON TARGETS. Lehar, F. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The possibilities for the study of nucleon–nucleon scattering measurements in the intermediate-energy region provided by polarized proton targets (PPT) are discussed. A list of possible experiments with different PPT; the present status of p–p, n–p, and p–n measurements; and the most recent results of phase-shift analysis are given. The possibilities of the verification of T invariance, P invariance, and charge independence are discussed. (auth)

13514 (LBL–500, pp 355-8) ELASTIC SCATTERING OF POLARIZED DEUTERONS FROM POLARIZED PROTON TARGET. Berovic, N.; Burcham, W. E.; Clews, C. J.; Maughan, R. L.; Rolph, P. M. (Birmingham Univ. (England)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

An experimental measurement of A_{1111} for p–d elastic scattering at 10 MeV is reported. (auth)

13515 (LYCEN–7152) D(p,d*)p CROSS SECTION FROM THE D(p,pn)p REACTION. Burq, J. P.; Cabrillat, J. C.; Chemarin, M.; Ille, B.; Nicolai, G. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1971. 25p. Dep. NTIS (U. S. Sales Only).

Three body break-up spectra from a kinematically complete measurement of the d(p,pn)p reaction were analyzed in order to determine the cross section for the production of d* (a neutron and a proton in a S = 0, T = 1 configuration). A 27.5-MeV deuteron beam and a 13.5-MeV proton beam were used, the proton and neutron being detected in coincidence at the same angle so as to enhance the detection of d(p,d*)p or p(d,d*)p events. The data were analyzed in terms of the Phillips, Griffy, and Biedenharn model for the final state interaction. Only n–p F.S.I. contribution accounts for the structure of all the observed spectra; other processes have essentially the same smooth shape in the region of the peak. An angular distribution for the d(p,d*)p reaction was obtained between $\theta_{d^*cm} = 20°$ and $\theta_{d^*cm} = 160°$ for the cms energy of 9.1 MeV. Other measurements for the d(p,d*)p reaction were made at forward angles for bombarding deuterons with energies between 19.2 and 27.5 MeV (this corresponds to ^{3}He excitation energies of between 11.8 MeV and 14.7 MeV); the d(p,d*)p excitation function shows no structure in this range. (France)

13516 (RLO–1388-148) PROTON–PROTON BREMSSTRAHLUNG MEASUREMENTS AT 20 MeV. Storm, Derek W.; Heffner, R. (Washington Univ., Seattle. Dept. of Physics). [1971]. 34p. Dep. NTIS.

The proton–proton bremsstrahlung cross section, $d\sigma/d\Omega_1 d\Omega_2$, was measured with 20-MeV incident proton energy, detecting coincident protons at 25 and at 30° on either side of the beam. In addition, the photon angular distributions, $d\sigma/d\Omega_1 d\Omega_2 d\theta_\gamma$ were determined. The value measured for $d\sigma/d\Omega_1 d\Omega_2$ for proton angles of 25° is 0.68 ± 0.07 $\mu b/sr^2$ while that for 30° is 0.69 ± 0.07 $\mu b/sr^2$. These results are for coplanar geometry and are determined from the data using the azimuthal angular dependence for the cross section predicted by Drechsel and Maximon. The results agree with the predictions of Marker and Signell, when Coulomb corrections are included. (auth)

13517 (TID–25874, pp 249-51) SUMMARY OF TOTAL CROSS-SECTION PROPOSALS. Mischke, R. E. (Princeton Univ., N. J.). 1970.

In 1970 summer study.

A summary of the hadron total cross-section proposals is presented, and a few additional comments are made. (auth)

13518 PHENOMENOLOGY OF MULTIPION PRODUCTION IN $\bar{P}P$ ANNIHILATION BASED ON AN ANALYSIS OF $\bar{P}P \rightarrow 5\pi$ AT 3.25 GeV/c. Rajaraman, R.; Jain, R. P. (Univ. of Delhi). Phys. Rev., D; 4: No. 9, 2768-74(1 Nov 1971).

Some data for the reaction $\bar{p}p \rightarrow 2\pi^+2\pi^-\pi^0$ at 3.25 GeV/c are analyzed. The dependence on different momentum-transfer variables, momentum distributions, and charge distributions are studied. The behavior with well-known characteristics of $\pi p \rightarrow$ nucleon + pions and $pp \rightarrow$ (2 nucleons) + pions is compared. The data are also compared with computer-generated events constrained only by Lorentz-invariant phase space (LIPS). It is found that the data agree in many respects with LIPS. Apart from a few statistically significant features mentioned in the text, the data show little dependence on the momenta or the charges. This is in sharp contrast with the pions produced in πp, Kp, or pp inelastic scattering. The result and its implications about annihilation processes are discussed and arguments are given as to why the result might be valid at higher energies as well. (auth)

13519 TEST OF PARITY CONSERVATION IN N–N SCATTERING. Gucker, E. J. (Univ. of Rochester, N. Y. State Univ. of New York Coll., Brockport); Thorndike, E. H. Phys. Rev., D; 4: No. 9, 2642-7(1 Nov 1971).

The parity-nonconserving double-scattering parameter a_k was measured at five laboratory scattering angles using a longitudinally polarized 210-MeV proton beam with targets of carbon and polyethylene. An impulse approximation was used to relate the proton-carbon scattering to nucleon-nucleon scattering. Beam polarization was reversed by a solenoidal magnetic field, and the asymmetry was taken between the counting rates observed for the two senses of polarization. Measured values of a_k are consistent with zero and suggest that, barring cancellation among terms, the ratio of parity-nonconserving amplitudes to parity-conserving amplitudes is less than 5×10^{-3}. Assuming time-reversal invariance, the parity nonconserving mixings of the $^1S_0$ and $^3P_0$ states and of the $^3S_1$ and $^1P_1$ states are, respectively, less than 10% and 3% of their maximum possible values. (auth)

13520 PROTON-ANTIPROTON ANNIHILATION INTO $\pi^+\pi^-$ AND K^+K^- FROM 700 TO 1100 MeV/c. Mandelkern, M. A.; Burns, R. R.; Condon, P. E.; Schultz, J. (Univ. of California, Irvine). Phys. Rev., D; 4: No. 9, 2658-66(1 Nov 1971).

Total and differential cross sections are presented for proton-antiproton annihilation into $\pi^+\pi^-$ and K^+K^- at six laboratory momenta between 686 and 1098 MeV/c. The two-pion final state displays moderate energy dependence in its differential cross section, but shows no evidence of any direct-channel resonances. In contrast, the two-kaon final state exhibits some behavior in the total and differential cross section suggestive of a possible direct-channel effect between 800 and 1000 MeV/c. (auth)

13521 DIFFERENTIAL CROSS SECTIONS FOR SMALL-ANGLE NEUTRON–PROTON AND NEUTRON–NUCLEUS ELASTIC SCATTERING AT 4.8 GeV/c. Ringia, F. E. (Univ. of Michigan, Ann Arbor); Dobrowolski, T.; Gustafson, H. R.; (and others). Phys. Rev. Lett.; 28: No. 3, 185-8(17 Jan 1972).

Measurements of the small-angle elastic scattering of 4.8-GeV/c neutrons from hydrogen and heavier nuclei are reported over the range of four-momentum transfer between 0.002 and 0.05 $(GeV/c)^2$. The data were used to determine the slope of the small-$|t|$ diffraction peak. The incident neutron beam covered a broad energy spectrum, and the detector included an ionization calorimeter to provide a measurement of the neutron energy. (auth)

13522 DEUTERON ALIGNMENT IN DEUTERON–PROTON ELASTIC SCATTERING AT 3.6 GeV/c. Bunce, G. (Univ. of Michigan, Ann Arbor); Overseth, O. E.; Walker, J.; (and others). Contract AT(11-1)-881. Phys. Rev. Lett.; 28: No. 2, 120-3 (10 Jan 1972).

A deuteron–proton double-scattering experiment was performed with a 3.6-GeV/c deuteron beam to study the spin alignment of the elastically scattered deuterons. Scattered beams of polarized deuterons were observed, and the spin alignment and vector polarization were measured in the four-momentum-transfer interval of $\Delta^2 = 0.13$ to 0.54 $(GeV/c)^2$. Multiple-scattering model fits are presented to the alignment and polarization data as well as to existing differential-cross-section data. (auth)

13523 PRODUCTION OF POSITIVE PARTICLES BY 70-GeV PROTONS. Gorin, Yu. P.; Denisov, S. P.; Donskov, S. V.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 14: No. 5, 994-7(Nov 1971). (In Russian).

Results are given of the first measurements of yields of positive particles (π^+, K^+ mesons, protons, and deuterons) on the 70-GeV accelerator of the Institute of High Energy Physics. (auth)

13524 DETERMINATION OF THE AXIAL FORM FACTOR OF THE NUCLEON FROM THE CROSS SECTION FOR ELECTROPRODUCTION OF PIONS AT THRESHOLD. Titov, Yu. I.; Severin, N. F. (Physical-Technical Inst., Kharkov). JETP Lett. (USSR) (Engl. Transl.); 14: No. 7, 288-90(5 Oct 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 7, 426-8(5 Oct 1971).

New data and that previously obtained are used to determine the axial form factor of the nucleon in the interval of the four-momen-

tum transfer squared from 2.5 to 10.4 F^{-2}. The cross sections for the electroproduction of pions at threshold is shown. (J.F.P.)

13525 TEST OF LIMITING BEHAVIOR FOR Λ AND K_1^0 PRODUCED IN INCLUSIVE pp INTERACTIONS. Berger, Edmond L. (Argonne National Lab., Ill.); Oh, B. Y.; Smith, G. A. Phys. Rev. Lett.; 28: No. 5, 322-5(31 Jan 1972).

New data are presented on longitudinal and transverse momentum spectra of Λ and K_1^0 produced in pp → Λ + anything and pp → K_1^0 + anything at 13, 18, 21, 24, and 28 GeV/c. The Λ spectra show little variation with energy. The K_1^0 inclusive cross section increases by ~50% over our energy range, the rise indicating that for this process the threshold for scaling and limiting fragmentation may be above 30 GeV/c. Tests of Mueller–Regge phenomenology are discussed. (auth)

13526 INELASTIC REACTION CROSS SECTIONS FOR THE np-INTERACTIONS AT NEUTRON MOMENTA FROM 2 UP TO 10 GeV/c. Gasparyan, A. P.; Nikitin, A. V.; Troyan, Yu. A. (Joint Inst. of Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 4, 764-70(Oct 1971). (In Russian).

A method to separate the reaction channels np → $np\pi^+\pi^-$ and np → $np\pi^+\pi^-(m\pi^0)$ (m = 1,2,...) is considered. Inelastic reaction cross sections of the np interactions are obtained. (auth)

Strong (Meson-Induced)

13527 (CEA-N-1497) ANALYSIS OF $\pi^-p \to \pi^-p$, $\pi^-p \to \pi^-\pi^0p$ AND $\pi^-p \to \pi^+\pi^-n$ REACTIONS AT 2.77 GeV/c AND A STUDY OF ππ ELASTIC SCATTERING APPLYING THE CHEW–LOW EXTRAPOLATION METHOD TO $\pi^-p \to \pi^-\pi^0p$ AND $\pi^-p \to \pi^+\pi^-n$ REACTIONS. Laurens, Georges (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1971. 146p. (In French). Dep. NTIS (U. S. Sales Only).

One hundred and eighty thousand photographs taken with the 2m CERN hydrogen bubble chamber with an incident beam of 2.77 GeV/c were examined. The quality of the statistics obtained throughout the entire angular production range enabled the differential cross section behavior, the mass and width of the ρ meson, and the multipole parameters of the resonance to be studied. The aim of this experiment was the application of the Chew–Low extrapolation method. Different types of extrapolation procedures were compared. Phase shift analysis of the elastic $\pi^-\pi$ scattering between 500 and 1100 MeV, performed with conformal mappings, allowed values to be determined for the S_0, S_2, P_1, D_0 and D_2 waves. Forward dispersion relations were used to obtain the scattering length values of the S_2 and P_1 phase shifts. (France)

13528 (COO-1428-293) REVIEW OF STRANGE BOSONS. Barnes, Virgil E. (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1971]. Contract AT(11-1)-1428. 53p. (CONF-710721-1). Dep. NTIS.

From Meson spectroscopy workshop; Argonne, Ill. (Jul 1971).

A review is given of the K* resonances. Emphasis is given to some newer values for various properties of the known K* states, possible new K* states, and phenomenological observations on possible regularities in present data. The theory is based on SU(3), the simple quark model, linear Chew–Frautschi plots, and current algebra. (J.F.P.)

13529 (COO-1428-299) TEST OF HELICITY CONSERVATION AND SPIN-PARITY ANALYSIS OF THE N*(1700). Lamsa, J. W.; Willmann, R. B.; Ezell, C. R.; Gaidos, J. A. (Purdue Univ., Lafayette, Ind.); Go, P. T.; Biswas, N. N.; Cason, N. M.; Kenney, V. P.; Shephard, W. D.; Smith, P. H. (Notre Dame Univ., Ind.). [1971]. Contract AT(11-1)-1428. 12p. Dep. NTIS.

The diffractively produced low-mass $\pi^+\pi^-p$ system is studied in the reaction $\pi^+p \to \pi^+\pi^+\pi^-p$. Strong N*(1700) production is observed, and the branching fraction to $\pi^-\Delta^{++}$ to be 65 ± 15% is determined. A spin-parity analysis (assuming $J < 7/2$) yields $J^P = 5/2^+$ for the N*(1700). The study of the decay angular distribution of the N*(1700) indicates that helicity is conserved in the t-channel rather than in the s-channel. (auth)

13530 (FRNC-TH-121) STUDY OF THE K^-–PROTON ELASTIC SCATTERING AT 14.3 GeV/c. Drevillon, Bernard (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 91p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Interactions between incident 14.3-GeV/c K^- and a proton target were investigated, 5200 events being studied from bubble chamber photographs. The results concerning elastic scattering are presented. The total elastic cross section, $\sigma_e = 2.83 \pm 0.15$ mb was obtained; it represents 13.1 ± 0.7 percent of the total cross section. The function, $\exp(a + bt + ct^2)$, was fitted to the experimental differential cross section data; the values obtained for the parameters are a = 3.02 ± 0.04, b = 7.4 ± 0.3 and c = 0.5 ± 0.5. An attempt was made to determine the imaginary part of the forward amplitude: this yielded $\lambda = 3.1 \pm 1.6$ mb/GeV/c^2, where delta represents the difference between the cross section extrapolated to t = 0 and the optical point. Considering its theoretical basis and the small number of parameters involved, the Mayers–Salin model gives the best agreement with the experimental results obtained. (France)

13531 (LBL-500, pp 167-78) POLARIZATION IN $\pi^\pm$–p, $K^\pm$–p, p–p AND $\bar{p}$–p FORWARD ELASTIC SCATTERING AT HIGH ENERGY FROM 6 TO 17.5 GeV/c. Borghini, M.; Dick, L.; Olivier, J. C.; (and others) (European Organization for Nuclear Research, Geneva (Switzerland)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The final results of an experiment to measure polarization in $\pi^\pm$ + p, $K^\pm$ + p, p + p, and $\bar{p}$ + p elastic forward scattering at incident momenta of 6, 10, 14, and 17.5 GeV/c are given. Cross sections are included for K^- + p and p + p elastic scattering at 10 GeV/c. (7 figures, 6 tables) (R.W.R.)

13532 (LBL-500, pp 179-85) POLARIZATION IN π–N BACKWARD ELASTIC SCATTERING AT HIGH ENERGY: A TYPICAL EXAMPLE OF MEASUREMENTS MADE AT LOW CROSS-SECTIONS. Aoi, H,; Aschman, D.; Booth, N. E.; (and others) (European Organization for Nuclear Research, Geneva (Switzerland)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The CERN "standard" polarized butanol target, together with a simple but good angular resolution apparatus, allows measurements to be made of hadron interactions having cross sections in the region of a few microbarns per $(GeV/c)^2$. Backward π–p elastic scattering at 6 GeV/c is currently of great theoretical interest, and has differential cross sections at this level. Comments are given on such an experiment, and the signal-to-background ratio is discussed. (auth)

13533 (LBL-500, pp 187-90) DISCUSSION OF THE BACKGROUND DUE TO BOUND PROTONS IN A POLARIZED TARGET USED FOR POLARIZATION MEASUREMENT OF HIGH ENERGY CHARGE EXCHANGE REACTIONS. Guisan, O. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

It is shown that polarization measurements of charge-exchange reactions at high energy with neutral outgoing particles can be performed without detecting the recoiling neutron. (auth)

13534 (TID-25874, pp 411-22) INCLUSIVE REACTIONS. Chien, C.-Y. (Johns Hopkins Univ., Baltimore, Md.); Engelmann, R. (Argonne National Lab., Ill.); Meunier, R. (European Organization for Nuclear Research, Geneva (Switzerland)); Panvini, R. (Brookhaven National Lab., Upton, N. Y.); Tenenbaum, J. (Stanford Linear Accelerator Center, Calif.); Tollestrup, A. (California Inst. of Tech., Pasadena). 1970.

In 1970 summer study.

Interests in inclusive reactions are discussed. Three proposed experiments are briefly described, and the kinematic regions accessible to and information available from them are discussed. (auth)

13535 (TID-25880) DETERMINATION OF THE ππ ELASTIC CROSS SECTION FROM THE REACTION $\pi^- + p \to \pi^- + \pi^+ + n$. Pewitt, Nelson Douglas (Florida State Univ., Tallahassee. Coll. of Arts and Sciences). Dec. 1971. Contract AT(40-1)-3509. 50p. Dep. NTIS.

Thesis.

The elastic cross section for $\pi^-\pi^+$ scattering is determined from 8291 events of the type $\pi^- + p \to \pi^- + \pi^+ + n$ at 2.3 GeV/c. A non-evasive Chew–Low extrapolation was used with the Taylor series expansion and the Padé approximant technique as the form of the extrapolation function. The values of the elastic ππ cross section exceed the p-wave unitarity limit at the ρ mass and agree well with the s plus p wave unitarity limit. The data are also inconsistent with a zero cross section at the four-momentum transfer t = 0. The Padé approximant or, equivalently, optimized polynomial is found to be a superior form for the extrapolation function. (auth)

13536 SIX-PRONG INTERACTIONS OF π^+ MESONS WITH PROTONS AT 8 GeV/c. Bardadin-Otwinowska, M.; Hofmokl, T.; Wojcik, W.; (and others). (Univ., Warsaw). Phys. Rev., D; 4: No. 9, 2711-39(1 Nov. 1971).

Final results for 3678 six-prong π^+p events at 8 GeV/c are presented. Single-particle distributions are compared with the predictions of the Chan-Loskiewicz-Allison model and the phenomenological model of the F(t) function. Differences between

the transverse momenta of the π^+ and π^- and between the transverse momenta of secondaries emitted forward and backward in the c.m. system are observed. Cross sections for production of the ρ^0, ρ^+, ρ^-, η, ω^0, X^0, and D^0 mesons and the N_{33}^{*++} and N_{33}^{*-} isobars are given, together with upper limits for some other resonances. The D^0 meson is observed in the seven-body channel in the $\eta\pi^+\pi^-$ system, with some evidence for the cascade decay $D^0 \to \delta^\pm\pi^\mp \to \eta\pi^+\pi^-$. The branching ratio $(f^0 \to 2\pi^+2\pi^-)/(f^0 \to 2\pi)$ is determined to be $(2.2^{+1.1}_{-2.2})\%$. Upper limits for the decay of A mesons into $X^0\pi$ systems are quoted. The cross section for the two-body reaction $\pi^+p \to N_{33}^{*++}X^0$ is determined to be 30 ± 13 μb, from which the η^0-X^0 mixing angle is derived. Associated production of N_{33}^{*++} and ρ^0 in the six-body channel and of N_{33}^{*++}, ρ^0, and ω^0 in the seven-body channel is studied, and the cross sections for reactions involving simultaneous production of these resonances are estimated. The Goldhaber-Goldhaber-Lee-Pais effect is studied and shown to be strong in the six-body channel, especially for selected events with low energy of the pion system. (auth)

13537 EXPERIMENTAL RESULTS ON THE REACTIONS $\pi^-p \to \pi\pi N$ IN THE c.m. ENERGY RANGE 1400 TO 2000 MeV. Brody, A. D. (Stanford Univ., Calif.); Cashmore, R. J.; Kernan, A.; (and others). Phys. Rev., D; 4: No. 9, 2693-2710(1 Nov 1971).

Cross sections and representative distributions are given for the reactions $\pi^-p \to \pi^+\pi^-n$, $\pi^-p \to \pi^-p\pi^0$ based on 85,000 inelastic events in the c.m. energy region 1400 to 2000 MeV. The angular distributions of beam, defined with respect to the final-state particles, are given in terms of their moments as a function of Dalitz plot position and c.m. energy. (auth)

13538 SEARCH FOR PERIPHERAL K^+ PRODUCTION IN π^-p INTERACTIONS FROM 2.75 TO 10 GeV/c. Bashian, A. (State Univ. of New York, Stony Brook); Finocchiaro, G.; Good, M. L.; (and others). Phys. Rev., D; 4: No. 9, 2680-3(1 Nov 1971).

Upper limits are presented for the differential cross section in the reactions $\pi^-p \to K^+\Sigma^-$ and $\pi^-p \to K^+Y^{*-}(1385)$ with small momentum transfer from π^- to K^+. (auth)

13539 REACTION $K^-n \to \pi^-\Lambda^0$ IN THE NEW INTERFERENCE MODEL. Kumar, Raj; Agarwal, B. K.; Singh, C. P. (Univ. of Allahabad, India). Phys. Rev., D; 4: No. 9, 2849-51(1 Nov 1971).

Experimental data on angular distribution and polarization for the process $K^-n \to \pi^-\Lambda^0$ at 3.0 GeV/c are explained on the basis of the new interference model. (auth)

13540 STUDY OF THE REACTIONS $\pi^+p \to K^+\Sigma^+$ AND $\pi^+p \to K^+Y^{*+}(1385)$ BETWEEN 3.5 AND 14 GeV/c. Bashian, A.; Finocchiaro, G.; Good, M. L.; (and others) (State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 9, 2667-79(1 Nov 1971).

Measurements of the differential cross section for the reactions $\pi^+p \to K^+\Sigma^+$ and $\pi^+p \to K^+Y^{*+}(1385)$ are reported at 3.5, 3.75, 4.0, 4.25, 4.5, 4.75, 5.0, 6.0, 10.0, and 14.0 GeV/c. Polarization in $\pi^+p \to K^+\Sigma^+$ is also reported at 6.0, 10.0, and 14.0 GeV/c. At small $|t|$, the cross section for $\pi^+p \to K^+\Sigma^+$ is well described by an exponential Ae^{bt} with slopes in the range $b \approx 8 - 10$ $(GeV/c)^{-2}$; for $|t| > 0.5$ $(GeV/c)^2$ this slope decreases considerably. The cross section for $\pi^+p \to K^+Y^{*+}(1385)$ is well described for $|t| > 0.2$ $(GeV/c)^2$ by a single exponential of slope about half that for $\pi^+p \to K^+\Sigma^+$; there is no break near $|t| = 0.5$ $(GeV/c)^2$. We observe a dip in this cross section near $t = 0$. The polarization in $\pi^+p \to K^+\Sigma^+$ is consistent with zero for $|t| < 0.4$ $(GeV/c)^2$ and becomes large and positive for larger $|t|$. (auth)

13541 CHARGE-EXCHANGE PRODUCTION MECHANISM FOR K*(890). Fox, G. C. (California Inst. of Tech., Pasadena); Engelmann, R.; Musgrave, B.; (and others). Phys. Rev., D; 4: No. 9, 2647-58(1 Nov 1971).

New results are presented on $K^-p \to K^-\pi^+n$ at 5.5 GeV/c. All the available $d\sigma/dt$ and decay density-matrix elements for the $K^+N \to K^{*0}N$ charge-exchange reactions are fitted. The difference between the K^+ and K^- reactions is explained successfully in terms of interference between a ρ Regge pole and strong absorptive corrections to the π Regge pole. This difference is related by vector dominance (VDM) to the π^+ and π^- photoproduction cross sections and polarized-photon asymmetry data. The VDM predictions are only qualitatively successful. (auth)

13542 K^+p ELASTIC SCATTERING BETWEEN 432 AND 939 MeV/c. Adams, C. J.; Davies, J. D.; Dowell, J. D.; (and others) (Univ. of Birmingham, Eng.). Phys. Rev., D; 4: No. 9, 2637-41(1 Nov 1971).

Data are presented from a spark-chamber study of K^+p elastic scattering between 432 and 939 MeV/c, over the range $-0.6 < \cos\theta_{c.m.} < +0.7$. With measurements at 13 momenta, and between 2000 events at the lowest momentum and 5000 events at the highest momentum, there is a major improvement over previous data. The elastic cross sections deduced from the differential cross sections are almost independent of momentum through the range covered. The data are inconsistent with counter measurements of the total cross section which suggest a sharp shoulder in the cross section at about 700 MeV/c. (auth)

13543 PROPERTIES OF THE K*(890) AND K*(1420) IN K^-p INTERACTIONS AT 3.9 AND 4.6 GeV/c. Aguilar-Benitez, M.; Eisner, R. L.; Kinson, J. B. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 4: No. 9, 2583-2628(1 Nov 1971).

Results are presented on the production and decay properties of the K(890) and K(1420) mesons as observed in K^-p interactions at 3.9 and 4.6 GeV/c. In addition, data on the elastic and charge-exchange reactions are also included. Total and differential cross sections, density-matrix elements, and S−P-wave interference effects are discussed in detail for both neutral and charged modes of the K(890). A measurement of the mass difference and comparison between the production properties of these two modes are presented. The mass and width parameters of the K(1420) meson and the possibility of the presence of more than one resonance in the 1400-MeV mass region are investigated. Branching ratios, total and differential cross sections, and a spin-parity determination are discussed. (auth)

13544 HIGH ENERGY PI-MINUS PROTON CHARGE EXCHANGE DIFFERENTIAL CROSS SECTION AT INTERMEDIATE MOMENTUM TRANSFERS. Brockett, William Stansberry. Cleveland; Case Western Reserve Univ. (1971). 79p. University Microfilms Order No. 72-22.

Thesis.

The measurement of the differential cross section for the reaction $\pi^-p \to \pi^0n$ for incident pion momenta of 3.67 and 4.83 GeV/c in the intermediate momentum transfer region is described. The momentum transfer interval studied was from -1.5 to -4.8 $(GeV/c)^2$ at 3.67 GeV/c and from -1.6 to -6.8 (GeV/c^2) at 4.83 GeV/c. The measurement was done in the 17° beam facility at the Argonne National Laboratory's Zero Gradient Synchrotron. Charge exchange interactions in a liquid hydrogen target were recorded by means of an optical spark chamber system which recorded sufficient information to permit a one constraint reconstruction of the data. Triggers from background and forward and backward charge exchange reactions were suppressed by a lead-scintillator neutral anti system. The differential cross sections were determined to within an overall normalization factor of ±20%. Both differential cross sections fell smoothly from either the forward or backward direction to a minimum value at approximately 90° in the π^-p center of mass systems. At 3.67 GeV/c the cross section at the minimum was 1.5 $\mu b/(GeV/c)^2$ and at 4.83 GeV/c the cross section at the minimum was 0.04 $\mu b/(GeV/c)^2$. The results of this experiment were interpreted in terms of a "cyclic residue" model of Barger and Phillips. No substantial agreement with this model was found. (Diss. Abstr. Int., B)

13545 π^- INTERACTIONS IN DEUTERIUM AT 7 GeV/c. Katz, Walter M. Rochester, N. Y.; Univ. of Rochester (1971). 170p. University Microfilms Order No. 72-727.

Thesis.

Results will be presented from a study of π^- deuterium interactions at an incident beam momentum of 7 GeV/c. The experiment to be described was performed at the 80-inch deuterium-filled bubble chamber at the Brookhaven National Laboratory AGS. The size of the exposure is such as to yield ~7 events per μb of cross section. The reactions to be discussed in this thesis are the following: (1) $\pi^-d \to pp\pi^-\pi^-$, (2) $\pi^-d \to pp\pi^-\pi^-\pi^0$, (3) $\pi^-d \to pp\pi^-\pi^- + N\pi^0$, N > 1, (4) $\pi^-d \to pp\pi^+\pi^-\pi^-\pi^-$, (5) $\pi^-d \to pp\pi^+\pi^-\pi^-\pi^-\pi^0$, and (6) $\pi^-d \to pp\pi^+\pi^-\pi^-\pi^- + N\pi^0$, N > 1. Stimulated by recent symmetry arguments a search was conducted for multipion resonances having two units of electric charge. No significant evidence was found for these exotic states in reactions (1), (2), (4), and (5); the upper limit for the production of such resonances in these reactions is ~5 μb. The s- and d-wave $\pi\pi$ scattering phase shifts were determined using a simple extrapolation procedure for the events from reaction (1). The deduced d-wave phase shift has the same sign as the s-wave phase shift. The value for the I = 2 s-wave phase shift at the mass of the K meson is $-11.0 \pm 2.5°$. In order to examine the validity of the spectator model (i.e., the hypothesis that in high energy experiments the deuteron can be treated as a source of essentially free neutrons and protons) the cross section for the $\Delta^0\rho^-$ channel in reaction (2) was compared with the $\Delta^{++}\rho^0$ cross section in the charge symmetric reaction $\pi^+p \to \Delta^{++}\rho^0$ at the same incident beam momentum. Assuming isotopic spin invariance the ratio of these cross sections is $^2/_9$; the observed ratio is found to be consistent with this prediction. This result suggests the validity of the spectator model. (Diss. Abstr. Int., B)

13546 STUDY OF THE REACTIONS WITH TWO CHARGED FINAL STATE PARTICLES IN π^+ PROTON INTERACTIONS AT

13.1 GeV/c. Kramer, Stephen Leonard. LaFayette, Ind.; Purdue Univ. (1971). 258p. University Microfilms Order No. 72-1902.

Thesis.

This report presents the results of a study of the reactions with two charged final state particles produced by π^+ proton collisions at 13.1 GeV/c. The data were obtained from a 230K picture exposure of the 82″ hydrogen bubble chamber at the Stanford Linear Accelerator. The particular reactions to be studied are $\pi^+p \rightarrow p\pi^+$, $p\pi^+\pi^0$, p MM$^+$, and $\pi^+\pi^+n$. A significant confirmation of the high mass boson states $A_2(1300)$, R(1700), T(2200) and X(2620) seen in previous missing mass experiments is provided by the MM$^+$ spectrum observed in this experiment. In addition the $\pi^+\pi^0$ mass spectrum indicates that narrow bosons with masses 1.65 ± 0.02, 1.97 ± 0.01, and 2.16 ± 0.01 GeV/c^2, the g, S, and T respectively, do have a two π decay mode. These data indicate that these states have quantum numbers $I^G = 1^+$ and spin parity series $J^P = 1^-, 3^-, 5^- \ldots$ with upper limits of $J^P = 3^-$, 3^-, and 5^- for the g, S, and T respectively. The g and T states are observed to be consistent with the $J^P = 3^-$ and 5^- states on the ρ trajectory, while the S state must be interpreted as a member of a daughter trajectory. The quasi-two body interactions $\pi^+ p \rightarrow \Delta^{++}\pi^0$, $p\rho^+$, $\Delta^{++}\eta^0$ and $\Delta^{++}f^0$ were studied and several are compared with the predictions of the Regge pole model. A search for possible exoti. $\pi^+\pi^+$ resonances was made with no significant observation of resonance structure. A study of the nonresonant contribution to the reactions $\pi^+p \rightarrow p\pi^+\pi^0$ and $\pi^+p \rightarrow \pi^+\pi^+n$ was made using the double-Regge pole model. Qualitative agreement with the former reaction is found, but the lack of resonances in the latter reaction results in a quantitatively excellent description of the data by this model. No significant nucleon exchange is required by either reaction. (Diss. Abstr. Int., B)

13547 BACKWARD K^-p ELASTIC SCATTERING BETWEEN 1.2 AND 2.5 GeV/c. Smith, Charles Anton. Rochester, N. Y.; Univ. of Rochester (1971). 167p. University Microfilms Order No. 72-769.

Thesis.

The backward elastic K^-p cross sections in the interval $-1.0 \leq \cos\Theta^* \leq -0.70$ with incident kaon momentum between 1.20 and 2.45 GeV/c were measured in the separated beam of the Alternating Gradient Synchrotron at Brookhaven National Laboratory. The angular distributions are binned in $\cos\Theta^*$ intervals of 0.02 and have a statistical uncertainty of 10 to 15%. A backward dip is present throughout the entire momentum range covered. The cross sections $d\sigma/du$ (u = o) decreases with increasing s as $\sim s^{-10}$. Two interpretations of the data are presented. In the first case, the data are interpreted in terms of a resonance model utilizing only the well established resonances in the K^-p system. In the second case, the data is interpreted in terms of Reggeized baryon exchange. Either method is adequate to interpret the data. (Diss. Abstr. Int., B)

13548 ONE AND TWO PRONG INTERACTIONS OF K^+ MESONS ON DEUTERIUM AT 5.5 GeV/c. Penn, John Francis. Madison, Wis.; Univ. of Wisconsin (1971). 144p. University Microfilms Order No. 71-25,498.

Thesis.

One and two prong events with or without seen K^0 decay, produced by K^+ mesons at 5.5 GeV/c colliding with deuterium nuclei, are examined. Analyzed are the charge exchange reaction $K^+n \rightarrow K^0p$, the inelastic reactions $K^+n \rightarrow K^0p\pi^0$, $K^+n \rightarrow K^0n\pi^+$, and $K^+p \rightarrow K^0p\pi^+$, coherent deuteron scattering in $K^+d \rightarrow K^0d\pi^+$, and the missing mass reactions $K^+n \rightarrow K^0p$ + MM and $K^+n \rightarrow K^0\pi^+$ + MM. The results include the partial cross sections for these reactions. The charge exchange reaction is seen to proceed mainly in the forward direction, and can be reasonably described by Regge pole theory. K*(892), K*(1420), Δ(1236), and N*(1700) production is observed and discussed for the inelastic reactions. Missing mass spectra are presented, with an analysis of the associated N* diffraction peak. Comparison is made with the missing mass spectrum in K^-p interactions at 5.5 GeV/c. (Diss. Abstr. Int., B)

13549 STUDY OF SOME FINAL STATES IN K^-d INTERACTIONS AT 5.5 GeV/c. Kropac, William Vincent. Evanston, Ill.; Northwestern Univ. (1971). 138p. University Microfilms Order No. 71-30,864.

Thesis.

The results presented were obtained from a bubble chamber analysis of K^-d interactions at an incident K^- momentum of 5.5 GeV/c. Generally, the quasi-two-body final states are produced peripherally, with a small backward peak occurring in some of the final states. In the final states $\Sigma^-\omega$, $\Sigma^-\rho^0$, $\Sigma^-\phi$ and $\Lambda(1520)\pi^-$, the exchange mechanism is investigated by using the density matrix formalism. The meson resonances appear to be produced primarily by vector exchange. The decay distributions of the Λ (1520) hyperon are found to be consistent with a vector exchange production process with M2 coupling at the nucleon vertex. The predictions of the independent quark model and of other symmetry schemes that the forward cross sections for $\Sigma^-\rho$, $\Sigma^-\omega$, $\Sigma^-\phi$ production be in the ratios 1 : 1 : 2 are not in agreement with the experimental values. Finally, using the reaction $K^-d \rightarrow K^-\pi^-pp_s$, the cross section for Kπ elastic scattering in the $I = 3/2$ state is measured by making use of the Chew–Low extrapolation procedure. The cross section does not exceed 2.1 mb for any Kπ mass interval and shows no structure for Kπ masses from threshold up to 2.0 GeV. (Diss. Abstr. Int., B)

13550 HIGH-ENERGY ETA MESON PRODUCTION AT LARGE MOMENTUM TRANSFERS. Kirby, Allan Robert. Cleveland; Case Western Reserve Univ. (1971). 67p. University Microfilms Order No. 72-60.

Thesis.

The results of a measurement of the partial differential cross section of the reaction $\pi^-p \rightarrow \eta^0n$ ($\eta \rightarrow 2\gamma$) in the momentum transfer intervals $1.3 \leq -t \leq 4.6$ and $1.0 \leq -t \leq 6.5$ (GeV/c)^2 with incident pion momenta of 3.67 and 4.83 GeV/c respectively are presented. These data were obtained in a counter and optical spark chamber experiment carried out at the Zero Gradient Synchrotron high energy physics facility of Argonne National Laboratory. The cross section measurement at 3.67 GeV/c shows a pronounced dip at $t = -1.5$ (GeV/c)^2. This result implies that the simple Regge pole models of this process should have an A_2 trajectory that is nearly degenerate with the ρ meson trajectory and a residue function which has a wrong signature nonsense zero at the momentum transfer of the dip. The cross section obtained at the higher incident momentum is quite uncertain due to the small amount of data available and is reported mainly to indicate the trend to be expected in future measurements of this type at higher energies. (Diss. Abstr. Int., B)

13551 PION–PROTON TOTAL CROSS SECTION FROM 0.4 TO 0.9 GeV/c. Davidson, Daniel. Tucson, Ariz.; Univ. of Arizona (1971). 67p. University Microfilms Order No. 72-1712.

Thesis.

The transmission method was used to measure the $\pi \pm p$ total cross sections from 420 to 900 MeV/c to a statistical accuracy of .5 percent. The work was performed at the UCLRL Bevatron using an unseparated pion beam and a liquid hydrogen target. The $\pi^+ p$ total cross section was found to be free of structure in the area investigated and agreed well with previous data. The $\pi^- p$ total cross section exhibited only the expected N(1512) resonance A qualitative mechanism is presented to explain systematic differences between these data and those of Carter et al. (Diss. Abstr. Int., B)

13552 $O^-1/2^+$ FINAL STATES IN K^-p INTERACTIONS AT 3.95 GeV/c. Moscoso, L. (CEN, Saclay, France); Hubbard, J. R.; Leveque, A.; (and others). Nucl. Phys.; B36: No. 2, 332-44(1972).

Final states $\pi^-\Sigma^+$, $\pi^+\Sigma^-$, $\pi^0\Lambda$ and $\eta\Lambda$ were studied for K^-p reactions at 3.95 GeV/c. Cross sections, angular distributions and polarizations are presented. Data for $\pi^-\Sigma^+$ and $\pi^0\Lambda$ production are compared to the line-reversed πp reactions at the same beam momentum. Baryon-exchange peaks are presented for the $\Sigma^+\pi^-$, $\Sigma^-\pi^+$, and $\Lambda\pi^0$ final states. (auth)

13553 K*(890) AND K*(1420) PRODUCTION IN QUASI TWO-BODY K^-p REACTIONS AT 10 GeV/c. Deutschmann, M. (Technische Hochschule, Aachen); Honecker, R.; Schmitz, P.; (and others). Nucl. Phys.; B36: No. 2, 373-403(1972).

Results are presented for six reactions induced by K^-p collisions at 10 GeV/c, where K*(890) and K*(1420) resonances are produced in association with a proton, a neutron, a $\Delta^+(1236)$ or $\Delta^0(1236)$ isobar. Partial and differential cross sections as well as density matrix elements are compared to one another and to previous results at lower energies. The following observations are made: (i)There is a first indication of a difference in the energy dependence of the pK^{*-} and nK^{*0} cross sections. (ii) In the $pK^{*-}(890)$ channel the ratio of π to ω exchange decreases with increasing energy. (iii) The ratio of π to ω exchange increases with the mass produced, the pion exchange contribution to the $pK^{*-}(1420)$ channel being larger than that to the $pK^{*-}(890)$ channel. (iv) Natural spin-parity exchange dominates in the $pK^{*-}(890)$ channel, but there are significant contributions of both natural and unnatural parity exchanges in the $nK^{*0}(890)$ channel. (v) There exists a clear hierarchy of exchanges such that when ω or f^0-exchanges are possible, they dominate over pion-exchange; pion exchange dominates over ρ or A_2-exchange in $\Delta Q = 1$ or $\Delta I = 1$ reactions, at least up to 10 GeV/c. (vi) Differential cross sections of $d\sigma/dt'$ of reactions dominated by pion exchange are better fitted by a two-exponential formula of the type P [exp (−Qt′) + R exp (−St′)] than by the pion propagator. (vii) At least ≈25% of the unnatural exchange in the $nK^{*0}(890)$ channel at 4–10 GeV/c must be due to mechanisms other than simple pion exchange. (auth)

13554 STUDY OF THE CHARGED THREE-PION SYSTEM IN THE MASS REGION OF 1400 TO 1900 MeV AND THE QUANTUM NUMBERS OF THE $A_3(1640)$. Caso, C. (INFN, Geneva); Teodoro, D.; Maddock, R. O.; (and others). Nucl. Phys.; B36: No. 2, 349-62(1972).

From an experiment on the reaction $\pi^+p \rightarrow \pi^+\pi^+\pi^-p$ at 11.7 GeV/c incident momentum a spin and parity analysis of the charged 3π system in the mass range of 1400 to 1900 MeV is presented. A broad (Γ = 200-400 MeV) enhancement in the $J^P = 2^-$, $f\pi$ (S-wave) state, centered at about 1650 MeV, was found, and no structure was found in the other $f\pi$ partial waves. Thus the J^P quantum numbers of $A_3 \rightarrow f\pi$ were determined to be $J^P = 2^-$. (auth)

13555 STUDY OF Δ^{++} PRODUCTION IN THE REACTION $\pi^+p \rightarrow \pi^+\pi^0p$ AT 13.1 GeV/c. Scharenguivel, J. H.; (Purdue Univ., Lafayette, Ind.). Gutay, L. J.; Gaidos, H.A.; (and others). Nucl. Phys.; B36: No. 2, 363-72(1972).

The production and decay angular distributions of the reaction $\pi^+p \rightarrow \pi^0\Delta^{++}$ were measured at 13.1 GeV/c incident momentum. For $-t > 0.1$ (GeV/c)^2 the data is well described by M1 ρ-exchange models, the best results being obtained from a weak cut model with a wrong signature nonsense zero. For $-t < 0.1$ (GeV/c)^2 there is evidence for the existence of other exchange mechanisms. (auth)

13556 INTERACTION OF NEGATIVE PIONS IN NUCLEAR EMULSION AT ENERGIES 7.5, 17, AND 60 GeV. Anzon, Z. V.; Takibaev, Zh. S.; Chasnikov, I. Ya. (Inst. of High Energy Physics, Alma-Ata, USSR). JETP Lett. (USSR) (Engl. Transl.); 14: No. 7, 273-5(5 Oct 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 7, 405-8(5 Oct 1971).

The integral distributions and energy dependence of the multiplicity and number of cascade-evaporation particles from π^- reactions with nuclei at 7.5 to 60 GeV in emulsions are discussed. (J.F.P.)

13557 INVESTIGATION OF THE $K^0_1K^0_1$ SYSTEM IN π^-p INTERACTIONS AT 4.0 AND 5.0 GeV/c. Boldea, V.; Budagov, Yu. A.; Vinogradov, V. B.; (and others) Joint Inst. for Nuclear Research, Dubna, USSR JETP Lett. (USSR) (Engl. Transl.); 14: No. 7, 278-80(5 Oct 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 7, 412-15(5 Oct 1971).

A study was made of the effective-mass spectrum of the $K^0_1K^0_1$ system in $\pi^- + p \rightarrow 2K^0_1 + n + m\pi^0$, $2K^0_1 + \pi^+ + \pi^- + n + m\pi^0$, and $2K^0_1 + \pi^- + p + m\pi^0$ interactions at 4.0 and 5.0 GeV/c in a propane bubble chamber. The mass and resonance width are found to be $M = 1032 \pm 24$ MeV/c^2 and $\Gamma = 40 \pm 20$ MeV/c^2. (J.F.P.)

13558 STUDY OF $\Sigma(1385)\pi$ PRODUCTION NEAR THE $\Lambda(1520)$ RESONANCE. Chan, Shu-bon; (Univ. of Massachusetts); Button-Shafer, Janice; Hertzbach, Stanley S.; Kofler, Richard R.; Schiff, Michel. Phys. Rev. Lett.; 28: No. 4, 256-9(24 Jan 1972).

The production mechanism of the reaction $K^-p \rightarrow \Sigma(1385)\pi$ with the total energy in the vicinity of the $\Lambda(1520)$ resonance was studied. Two different analysis techniques were used: partial waves and moments. The results establish the decay mode $\Lambda(1520) \rightarrow \Sigma(1385)\pi$. Conclusions on $\frac{1}{2}^-$ octet-singlet mixing are presented. (auth)

13559 OBSERVATION OF AN S-WAVE RESONANCE IN THE f^0 MASS REGION. Carroll, J. T. (Univ. of Wisconsin, Madison); Diamond, R. N.; Firebaugh, M. W.; (and others). Contracts AT(11-1)-881; AT(40-1)-3065. Phys. Rev. Lett.; 28: No. 5, 318-22(31 Jan 1972).

$\pi\pi$ scattering in the reactions $\pi^-p \rightarrow n\pi^+\pi^-$ and $\pi^+n \rightarrow p\pi^+\pi^-$ at 7 GeV/c is studied using the absorption-modified one-pion-exchange formalism. Fitting the $\pi\pi$ angular distributions yields S-, P-, and D-wave $\pi\pi$ phase shifts and inelasticities for $0.6 < M(\pi\pi) < 1.5$ GeV/c^2. An I = 0 S-wave resonance with $M = 1.25 \pm 0.04$ and $\Gamma = 0.3 \pm 0.1$ GeV/c^2 is found. Support for the phase shifts in the f^0 mass region is obtained from data on $\pi^+n \rightarrow pK^+K^-$ and $\pi^+n \rightarrow p\pi^0\pi^0$ at 7 GeV/c. (auth)

13560 ANGULAR VARIATION OF POLARIZABILITY OF n-D SCATTERING AT 2.6 MeV. Piffaretti, J. (Univ., Neuchatel, Switzerland). Helv. Phys. Acta; 44: No. 6, 763-83(1 Oct 1971). (In French).

The polarization of 2.6-MeV neutrons elastically scattered on deuterium was determined by measuring the left-right asymmetry of polarized neutrons from the $^{12}C(d,n_0)^{13}N$ reaction (initial deuterons energy 3 MeV, emission angle 20° lab) by the time of flight method. An extensive study of the possible instrumental asymmetries is made and it is shown how most of them can be eliminated by a suitable choice of the measurement method. A new polarimeter using a single photomultiplier connected to two scintillation detectors is described. The main advantage of this device is to greatly reduce the asymmetry resulting from gain variations of the photomultiplier. The results after multiple scattering correction are: θ_{CM}, P_1P_2, and P_2 for 68° (−0.39 + 0.5)% and (+1.0 ± 1.2)%, for 88° (−1.64 + 0.37)% and (+4.1 ± 1.0)%, and for 146° (−0.48 + 0.75)% and (+1.2 ± 1.8)%, (taking the polarization P_1 of the incident neutrons to be (−40 ± 2)%. These results agree with predictions based on a recent effective range fit by Viennet. (auth)

13561 STUDY ON THE PROPERTIES OF HYPERONS AND HYPERFRAGMENTS IN NUCLEAR EMULSION EXPOSED TO 3 GeV/c NEGATIVE K MESONS. Husain, A.; Basak, A. K.; Pramanik, M. H. A.; Ali, M. P. (Rajshahi Univ., East Pakistan). Sci. Ind. (Karachi); 8: No. 2, 180-93(Apr 1971).

A systematic study was made on 1594K^- stars in a stack of Ilford G5 emulsion plates exposed to 3-GeV/c negative K mesons at CERN, Geneva. The average prong number of the stars was 8.98 and the maximum prong number was 30. In the 186 cases examined the charged Σ hyperons were found to be emitted, 60 of which were found to decay. There were 16 protonic and 15 pionic decays at rest, 13 protonic and 13 pionic decays in flight and 3 leptonic decays. This leads to the probability (5.56 ± 2.81 per cent) of the leptonic decay mode of Σ hyperons. The distribution of the decay pions supports the idea that the spin of Σ hyperon might be greater than $\frac{1}{2}$. There were 55 cases of hyperfragments including 4 possible 2 hyperfragments and 4 possible double hyperfragments. The average charge of the hyperfragments was 3.4. The ratio of nonmesonic to mesonic decays was (1.90 ± 0.94) and the probability of the hyperfragment formation was found to be (3.51 ± 0.41%). The increase in the binding energy of Λ^0 in the hyperfragments with the baryon number shows that its occupation number does not obey the Pauli exclusion principle. Two examples of the charge-exchange reaction ($K^- \rightarrow K^0$ were found and its cross section came out to be 22.99 millibarn. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 13486.

13562 (JINR-P2-6181) COMPOSITE PARTICLE CURRENTS. Bogolyubov, P. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

Current matrix elements are considered in the framework of the relativistic quark model. The decays of the type $B \rightarrow B' + \gamma$, $B \rightarrow B' + \pi$, $M \rightarrow M' + \pi$ ... are studied on their basis. (auth)

13563 TESTING FOR CORRELATIONS IN MULTIPARTICLE PERIPHERAL REACTIONS INVOLVING CLUSTERS. Morrow, Richard A. (Univ. of Maine, Orono). Phys. Rev., D; 4: No. 9, 2921-2(1 Nov 1971).

It is shown that a composite distribution in the Toller angles ω associated with a given internal vertex in multiparticle peripheral reactions is flat if certain (two-, three-, four-, ...) particle correlations are absent and a particular selection of data is made. (auth)

13564 METHOD OF CALCULATING UNITARY WEIGHTS IN THE THEORY OF MULTIPLE PARTICLE PRODUCTION. Barashenkov, V. S.; Beshtoev, Kh. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol.; B2: No. 6, 803-6 (Nov-Dec 1971). (In Russian).

A method is given of calculating unitary weights in the statistical theory of multiple particle production. This method is considerably simpler than those given in literature. (auth)

13565 APPROXIMATION TO THE MASS DISTRIBUTION. Alonso, J. L. (Laboratoire de Physique Theorique, Orsay, France); Galindo, A. Lett. Nuovo Cim.; 3: No. 1, 17-21 (1 Jan 1972).

A proposal is made for two recurrence expressions and an approximative formula to compute phase-space mass distributions easily generalizable to the case where the squared transition matrix element is not constant. It is emphasized that the computing time needed using this formula is independent of the number of particles. (J.F.P.)

13566 HIGH ENERGY PHYSICS INDEX. VOLUME 9, No. 22, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 73p.

13567 REINTERPRETATION OF DECAY EXPERIMENTS. Ekstein, H. (Argonne National Lab., Ill.); Siegert, A. J. F. Ann. Phys. (N. Y.); 68: No. 2, 509-20(Dec 1971).

Discussion of the basic formula conventionally used to interpret decay measurements shows that it is incompatible with the accepted physical interpretation of quantum mechanics. Two alter-

native theoretical correlates of the actual experiments are discussed. The first assumes a sequence of observations performed on the same object, each causing a collapse of the wave function. The second theory constructs a time-of-sojourn operator on the assumption that the protracted interaction between object and measurement apparatus is "gentle." The first theoretical formula is developed with the result that the decay probability shows an asymptotic decrease which is at least exponential, contrary to the conventional theory. (auth)

13568 EQUAL-TIME COMMUTATORS BETWEEN SPATIAL CURRENT COMPONENTS. Gomberoff, L. (Tel-Aviv Univ., Israel). Phys. Rev., D; 4: No. 10, 3228-9(15 Nov 1971).

The conditions discussed by Buccella et al. in connection with the consistency between the Lee–Dashen–Gell–Mann and Cabibbo–Radicati sum rules are analyzed. It is shown that only one of the two alternative conditions proposed by them is compatible with our present understanding of q-number Schwinger terms. (auth)

13569 NOTE ON THE SOFT-MESON LIMIT AND THE DISPERSION RELATION. Fukuda, R. (Tokyo Univ.). Phys. Rev., D; 4: No. 10, 3226-7(15 Nov 1971).

Dispersion relations in the hard-meson limit and the soft-meson limit are considered. They take different forms, and a precise relation between the equal-time commutator term and the subtraction constant is given. (auth)

13570 CORRELATION BETWEEN SCHWINGER TERMS AND THE ENERGY-DENSITY OPERATOR. Gomberoff, L. (Tel-Aviv Univ., Israel). Phys. Rev., D; 4: No. 10, 3202-5(15 Nov 1971).

Following a recent study made by Okubo on the general properties of q-number Schwinger terms in current algebra, it is shown that when the equal-time commutator between a current divergence and a charge is a Lorentz scalar, no Schwinger terms are present in commutators involving current divergences and current divergences with current components. These considerations are then applied to the model proposed by Gell–Mann, concerning the structure of the energy-density operator. (auth)

13571 CURRENT DEFINITIONS IN FERMION MODELS. Grant, Necia Joy. Providence; Brown Univ. (1969). 128p. University Microfilms Order No. 71-13,870.

Thesis.

It is well-known that the naive strictly local quark currents, $\frac{1}{2}\bar{\psi}_{(x)}\lambda_i\alpha^u\psi_{(x)}$, which satisfy the complete Gell–Mann current algebra commutation relations, are not valid current operators since they fail to predict nonvanishing Schwinger terms. A consistent definition for these spinor currents involves defining the singular limit of a product of Fermi fields at noncoincident points. The point of view is taken that a suitable limit for the quark current operators should not only yield the Schwinger terms necessary for Lorentz invariance, but should also predict the so-called anomalous vertex contributions and current commutators like those recently discovered for the neutral axial vector current. It should be pointed out, however, that this formal operator approach, i.e., the point-splitting technique, is not free of ambiguities. In particular, calculations of equal time commutators using these operators seem to be unreliable so that the nature of the complete Gell–Mann algebra remains an open question. At the conclusion of the investigation the limitations of this technique and alternate approaches to the question of anomalies and equal time commutators are discussed. (TSS) (Diss. Abstr. Int., B)

13572 APPROACH TO THE BROKEN SU(3) SYMMETRY SUM RULES. Matsuda, Seisaku. College Park, Md.; Univ. of Maryland (1971). 115p. University Microfilms Order No. 72-636.

Thesis.

An approach to sum rules in the broken SU(3) symmetry based on the idea of a chiral SU(3) × SU(3) algebra is discussed. The approach is to make full use of the information obtained from the charge–charge and charge–charge density commutation relations obtained from the algebra by making essentially two approximations which seem well founded. (TSS) (Diss. Abstr. Int., B)

13573 ELEMENTARY PARTICLES. SCIENCE, TECHNOLOGY, AND SOCIETY. Yuan, Luke C. L. (ed.). New York; Academic Press Inc. (1971). 323p. $15.00.

The book included seven chapters. Separate abstracts were prepared for each chapter. (J.F.P.)

For abstracts of individual chapters see: 12201, 12390, 13486, 13487, 13574, 13575, and 13898.

13574 ELEMENTARY PARTICLE INTERACTIONS IN ASTROPHYSICS. Ruderman, M. A. (Imperial Coll. of Science and Tech., London); Fowler, William A. pp 49-73 of Elementary Particles. Science, Technology, and Society. /Yuan, Luke C. L. (ed.). New York; Academic Press Inc. (1971).

Past contributions of high-energy physics to astrophysics are discussed, and speculation is made on future developments. (J.F.P.)

13575 INTERACTIONS OF ELEMENTARY PARTICLE RESEARCH WITH CHEMISTRY. Kaufman, Sheldon (Argonne National Lab., Ill.). pp 159-93 of Elementary Particles. Science, Technology, and Society. /Yuan, Luke C. L. (ed.). New York; Academic Press Inc. (1971).

The discussion covers the theoretical framework for high-energy nuclear reactions and the types of processes which are thought to occur. The experimental techniques used and some of the results are described together with some numerical calculations. The applications of beam monitoring by activation and the problem of radioactivity induced in the accelerator and its shielding material are covered. (J.F.P.)

13576 LOOP CONTRIBUTIONS TO THE SUM RULES FOR INCLUSIVE CROSS-SECTIONS. Arbab, F. (Univ. del Valle, Cali, Colombia); Gallardo, J. C.; Masperi, L.; Rebbi, C. Lett. Nuovo Cim.; 2: No. 24, 1245-50(11 Dec 1971).

An attempt is made to saturate sum rules for inclusive cross sections which relates the discontinuities of the four- and six-point amplitudes within the framework of the dual-resonance model in the tree graph approximation. It is shown that the sum rules are saturated only when loop graphs are taken into account. (L.B.S.)

13577 REMARKS ON THE THEORY OF FIREBALLS AND ON THE RELATIVISTIC NONLOCAL THEORIES. Wataghin, Gleb. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 49: No. 6, 387-8(Dec 1970).

A brief summary of work on the direction and velocity of fireball emission and the predictions of nonlocal field theory for asymptotic behavior of inelastic cross sections in cosmic ray jets is given. (J.F.P.)

13578 REMARKS ON THE ORIGIN OF THE DEVIATIONS FROM THE EXPONENTIAL DECAY LAW OF AN UNSTABLE PARTICLE. Fonda, L. (International Centre for Theoretical Physics, Trieste, Italy. Univ., Trieste, Italy); Ghirardi, G. C. Nuovo Cim.; 7A: No. 1, 180-4(1 Jan 1972).

The connection between the deviations from the exponential law appearing in the decay time plot of an unstable particle for large times and the regeneration of the unstable state is investigated. It is found that the contribution of the decayed states to the regeneration process is of paramount importance. (auth)

13579 RELATION OF THE INFINITESIMAL PARTICLE PROPAGATOR TO THE NATURE OF MASS. Hoyle, F.; Narlikar, J. V. (Cambridge Univ., Eng.). Nuovo Cim.; 7A: No. 1, 242-61(1 Jan 1972).

The infinite particle propagator can be constructed by a path integral method provided the infinitesimal propagator is known. Hitherto, however, it has not been possible to specify the relativistic infinitesimal propagator except in an ad hoc way. From consideration of the nature of mass, in a Machian cosmological sense, it is shown that the infinitesimal propagator can be derived in relativistic quantum mechanics by a method similar to that used in the nonrelativistic path integral. (auth)

13580 HADRONIC HYPERON DECAYS IN THE SYMMETRIC QUARK MODEL. Gronau, Michael (California Inst. of Tech., Pasadena. Stanford Univ., Calif.). Contract AT(11-1)-68. Phys. Rev. Lett.; 28: No. 3, 188-91(17 Jan 1972).

The current–current quark model provides a two-parameter description of the S- and P-wave nonleptonic decay amplitudes of hyperons. (auth)

13581 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 25, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 81p.

Electromagnetic

Refer also to abstracts 13754, 13796, 13813, and 13881.

13582 (LNF-71/59) GENERALITIES ON THE ELECTROMAGNETIC INTERACTIONS OF HADRONS. Bernardini, C. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Sep 1971. 34p. Dep. NTIS (U. S. Sales Only).

The topics covered include the electrodynamics of hadrons, quantum numbers, currents, matrix elements of currents, static moments, experiments on static moments, the role of isospin, classification of the cross sections, photon polarization problems, and two-photon reactions. (J.F.P.)

13583 (LNF-71/61) DIFFERENTIAL CROSS SECTION FOR THE PROCESS $e^+e^- \rightarrow \mu^+\mu^-\gamma$ AND RADIATIVE EVENTS. D'Ettorre Piazzoli, B. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 15 Sep 1971. 16p. Dep. NTIS (U. S. Sales Only).

A general formula is established for the differential cross section for $e^+ + e^- \rightarrow \mu^- + \mu^+ + \gamma$ interactions taking into account the hard photon emission by both initial and final states. It is assumed that the muon charge is not measured. Standard perturbation theory in the one-photon exchange approximation is used. The results are applied to establish the cross section for radiative events in which only the directions of the final muons are detected. (J.F.P.)

13584 (LNF-71/66) ANGULAR CORRELATIONS OF THE DECAY PRODUCTS OF TWO HEAVY LEPTONS. Parisi, G.; Zirilli, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 4 Oct 1971. 3p. Dep. NTIS (U. S. Sales Only).

The angular distributions of the produced charged particles in the decay of the two charged heavy leptons produced in the $e^+ + e^- \rightarrow X^+ + X^-$ interactions in colliding beams are determined. (J.F.P.)

13585 (TID-25874, pp 179-85) MUON PHYSICS. Derenzo, S. (California Univ., [Livermore]. Lawrence Radiation Lab.); Tannenbaum, M. 1970.

In 1970 summer study.

Muon experiments may be divided into two broad categories. First, there are experiments studying the muon itself. These seek to understand the fundamental nature of the leptons: Why does the muon exist? If the muon is a heavy electron, why do the muon and electron have different neutrinos and separately conserved lepton numbers? What accounts for the observed lepton mass spectrum: ν_e, ν_μ, e, μ? Second, there are experiments which use the virtual photon from muon inelastic scattering as a probe of hadronic structure. These experiments have been stimulated by the deep inelastic scattering results from SLAC. The hadronic probes are discussed, and then the muon and neutrino inelastic experiments are compared as to rates and other features. (auth)

13586 (TID-25874, pp 187-95) MUONS AND ELECTROMAGNETIC INTERACTION AT NAL: A THEORIST'S VIEW. Tsai, Yung-su (Stanford Linear Accelerator Center, Calif.). 1970.

In 1970 summer study.

Some of the interesting things one would like to learn using $e^\pm$, $\mu^\pm$, and γ beams derived from a 500-GeV proton beam from NAL are discussed. Topics discussed include $\mu-e$ relative locality and radiative corrections, excited state of μ, heavy leptons and $W^\pm$ bosons, inelastic μ (or e) + p scattering, and production of ρ by a virtual γ from proton. The amazing thing about NAL is that, even though it is a proton machine, it will produce enough high-energy $e^\pm$, $\mu^\pm$, and γ beams to make unique contributions to the fields of very-high-energy electromagnetic interactions until SLAC becomes a long-duty-cycle machine at energy equal to 200 GeV or more. (auth)

13587 (TID-25874, pp 231-9) INELASTIC SCATTERING, THE VIRTUAL RADIATOR AND ENERGY LOSS BY RELATIVISTIC MUONS. Tannenbaum, Michael J. (Harvard Univ., [Cambridge], Mass.). 1970.

In 1970 summer study.

Simple formulas for direct pair production are derived from the general equation for inelastic lepton scattering. Applications to energy loss by high-energy muons are discussed. (auth)

13588 (TID-25874, pp 391-6) ESTIMATE OF THE PRODUCTION OF BOUND MAGNETIC MONOPOLE STATES. Trefil, J. S. (Illinois Univ., Urbana). 1970.

In 1970 summer study.

Because of the strong attraction between a monopole and antimonopole produced as a pair, there is a strong likelihood that a pair which is produced will tend to become bound. In a nonrelativistic model, it is estimated that the ratio of bound-state to free-pair production is 10^{10} for production of a low-lying state and decreases rapidly for higher lying states. This prediction is independent of the production mechanism of the monopoles. (auth)

13589 REMARKS ON THE HADRON DISTRIBUTIONS IN ELECTROPRODUCTION. Hwa, Rudolph C.; Lam, C. S. (State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 9, 2865-73(1 Nov 1971).

A model for electroproduction is discussed. It is an extrapolation from the diffractive model for the hadron-hadron collisions. The principle involved in the extrapolation is the idea that coherent particles can be produced when momentum transfer between the virtual photon and the target proton can be sufficiently small. In the deep-inelastic region there are unavoidably many incoherent products. A comparison of our model with that of Chou and Yang recently proposed for electroproduction is discussed. Multiplicity and momentum distributions of the secondary hadrons are described. (auth)

13590 SCALING AND THE BEHAVIOR OF NUCLEON RESONANCES IN INELASTIC ELECTRON-NUCLEON SCATTERING. Bloom, E. D.; Gilman, F. J. (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 9, 2901-16(1 Nov 1971).

The behavior of elastic scattering and of the electroproduction of nucleon resonances is shown to be closely related to the behavior of deep-inelastic electron-nucleon scattering. This relation is discussed in the context of duality ideas taken from strong-interaction processes. These ideas suggest that a substantial part of the observed behavior of inelastic electron-nucleon scattering is due to a nondiffractive component of virtual photon-nucleon scattering. Through finite-energy sum rules, quantitative relations between the elastic and resonance electroproduction form factors and the deep-inelastic scattering are derived and the behavior of inelastic scattering near threshold is calculated. (auth)

13591 QUANTUM THEORETIC EXPLANATION OF THE SCHWARZ-HORA EFFECT. Kumar, N.; Sinha, K. P. (Indian Inst. of Science, Bangalore). Proc. Indian Acad. Sci., Sect. A; 74: No. 2, 91-8(Aug 1971).

Following the path-integral approach it is shown that the Schwarz-Hora effect is a one-electron quantum-mechanical phenomenon in that the de Broglie wave associated with a single electron is modulated by the oscillating electric field. The treatment brings out the crucial role played by the crystal in providing a discontinuity in the longitudinal component of the electric field. The expression derived for the resulting current density shows the appropriate oscillatory behavior in time and distance. The possibility of there being a temporal counterpart of Aharonov-Bohm effect is briefly discussed in this context. (auth)

13592 INELASTIC ELECTRON-PROTON SCATTERING AND VECTOR-MESON DOMINANCE. Fujikawa, Kazuo (Univ. of Chicago). Phys. Rev., D; 4: No. 9, 2794-6(1 Nov 1971).

A simple phenomenological picture of scaling is proposed based on generalized vector-meson dominance. This picture may provide a possible mechanism of scaling in the context of an analytic-S-matrix approach such as the dual-resonance model. The present model suggests that a very weak spectral function in the large-photon-mass region is sufficient to give the magnitude and shape of scaling-limit functions. Thus the measurement of νW_2 explains why ρ-meson dominance works in high-energy photoreactions. Experimental implications of the model, in particular the expected missing-mass distribution, are also discussed. (auth)

13593 DECAY CORRELATIONS OF HEAVY LEPTONS IN $e^+ + e^- \rightarrow l^+ + l^-$. Tsai, Yung-su (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 9, 2821-37(1 Nov 1971).

Assuming that leptons heavier than muons exist in nature, their decay modes and the correlations between the decay products of l^+ and l^- are considered in the colliding-beam experiment: $e^+ + e^- \rightarrow l^+ + l^-$. Far above the threshold, the helicities of l^+ and l^- tend to be opposite to each other. Near the threshold the directions of spins of l^+ and l^- prefer to be parallel to each other, and the sum of the two spins prefers to be either parallel or antiparallel to the direction of the incident electron. Because the parity conservation is violated maximally in the decays of l^+ and l^-, the angular distributions of decay products depend strongly on the spin orientation of the heavy leptons. Since the spins of l^+ and l^- are strongly correlated in the production, a strong correlation is found between the energy-angle distributions of the decay products of l^+ and l^-. The decay widths of l^- into channels $\nu_l\bar{\nu}_e e^-$, $\nu_l\bar{\nu}_\mu\mu^-$, $\nu_l\pi^-$, $\nu_l K^-$, $\nu_l\rho^-$, $\nu_l K^{*}$, $\nu_l A_1$, $\nu_l Q$, and ν_l + hadron continuum as functions of the mass of l^- are estimated. (auth)

13594 NUCLEON FORM FACTORS, VECTOR DOMINANCE, AND LORENTZ CONTRACTION. Licht, Arthur Lewis; Pagnamenta, Antonio (Univ. of Illinois, Chicago). Phys. Rev., D; 4: No. 9, 2810-21(1 Nov 1971).

The notion of Lorentz contraction of a composite cluster combined with vector-meson dominance of the one-photon exchange is used to derive the asymptotic form of the nucleon form factors. For the three-quark model a t^{-2} prediction is found which fits the data very well at large spacelike t. Only the observed vector mesons, ρ, ω, and ϕ, are used. The results predict deviations from the scaling laws which are directly related to the nonvanishing electric form factor of the neutron and are of the same magnitude. (auth)

13595 IMPLICATIONS OF THE VENEZIANO MODEL TO VECTOR-MESON DOMINANCE FOR THE ELECTROMAGNETIC FORM FACTORS. Gounaris, G. J. (Democritus Nuclear Research Center, Athens). Phys. Rev., D; 4: No. 9, 2788-93(1 Nov 1971).

The Frampton Veneziano-type model for the nucleon form factor is studied in detail. It is found that the predictions of the model for $F_1^V(t)$ and $F_1^S(t)$ are almost indistinguishable from the vector-meson dominance (VMD) predictions in the region $0 < t < 0.8$ GeV^2. Consequently, these two models imply the same relations for the Dirac coupling constants of ρ, ω, and ϕ to the nucleon and to the photon. If the Frampton model has anything to do with reality, it also implies that no VMD assumption can be made for $F_2^V(t)$ and $F_2^S(t)$ even if restricted to small regions around the ρ and ω. Finally, by making analogous assumptions for the pion form factor, it is argued that higher ρ mesons (ρ', ρ'', etc.) are coupled more strongly to the nucleon than to the pion and that the pion form factor is vanishing asymptotically more slowly than the nucleon form factor. This suggests that it might be profitable to look for these mesons in backward production in $\pi-N$ scattering, and provides an explanation of the difficulty of discovering them up to now. (auth)

13596 PREDICTIONS OF THE PARTON DUAL-RESONANCE MODEL FOR THE TOTAL CROSS SECTION OF ELECTRON–POSITRON ANNIHILATION INTO HADRONS. Yu, Loh-ping (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 9, 2785-7(1 Nov 1971).

On the assumption that a heavy virtual photon behaves like a parton-antiparton pair when participating in the strong interaction, it is predicted that the total cross section for $e^+e^- \to$ hadrons, as $q^2 \to \infty$, behaves like $Cq^{-4}(|q^2|\ln|q^2|)^{-1}$ for spin-0 partons, and like $C'q^{-4}(\ln|q^2|)^{-1}$ for spin-$\frac{1}{2}$ partons, where q^2 is the virtual photon's mass squared. This provides a simple, yet important test of the parton dual-resonance model for deep-inelastic lepton-hadronic scattering, proposed in a previous paper. (auth)

13597 TWO-PHOTON PROCESSES IN COLLIDING-BEAM EXPERIMENTS. Carlson, C. E. (Univ. of Chicago); Tung, Wu-ki. Phys. Rev., D; 4: No. 9, 2873-84(1 Nov 1971).

The general structure of the two-photon process in colliding-beam experiments, $e + e \to e + e + \Gamma$, is studied for an arbitrary hadron final state Γ. The dependence of the scattering amplitudes on the lepton variables is explicitly factored out from the helicity amplitudes for the basic (hadronic) process $\gamma + \gamma \to \Gamma$. General formulas are given for the differential cross section as well as for important special cases. The most important inclusive channel ($\gamma + \gamma \to$ anything) and exclusive channel ($\gamma + \gamma \to \pi + \pi$) are studied in some detail. The first case can yield information on the fundamental process $\gamma + \gamma \to \gamma + \gamma$. The second case provides a clean method for extracting the S-wave $\pi-\pi$ phase shifts. (auth)

13598 ELECTROPRODUCTION FROM NUCLEONS IN A RELATIVISTIC QUARK MODEL. Copley, L. A. (Carleton Univ., Ottawa); Karl, Gabriel; Obryk, E. Phys. Rev., D; 4: No. 9, 2844-8(1 Nov 1971).

A relativistic formulation of the quark model recently proposed by Feynman, Kislinger, and Ravndal is applied to electroproduction of nucleonic resonances. Formulas for the ratio of longitudinal to transverse photoabsorption cross sections that are relevant to both the resonance and deep-inelastic regions are derived. This formulation is found to be much more successful than the nonrelativistic symmetric quark model and is consistent with the existing data. (auth)

13599 COMMENT ON THE EXPERIMENTAL INVESTIGATION OF PHOTON–PHOTON COLLISIONS IN ELECTRON–POSITRON STORAGE RINGS. Parisi, J. (Univ., Paris). Phys. Rev., D; 4: No. 9, 2927-35(1 Nov 1971).

Continuing calculations on photon–photon collisions in electron–positron storage rings, i.e., reactions of the type $e^-e^- \to e^-e^+A^-A^+$ (where A = e, μ, π, K, ...), realistic experimental conditions are introduced, in particular two cutoff parameters: a minimal emission angle (ψ_{min}) with respect to the beam axis for the particles $A^\pm$ to be produced, and a minimal relative energy loss (χ_{min}) for the outgoing electron and positron (to be detected practically in their forward directions). Taking realistic values for ψ_{min} and χ_{min}, their effect on the invariant mass spectrum of the pair A^-A^+ and on the integrated cross section is shown. In particular, the modification of the energy behavior, due to these cutoffs, is exhibited. In spite of the drastic character of the restrictions considered, it is shown that fairly high counting rates may still be expected (for A = e, μ, π) in the four-fold coincidence experiments suggested, with electron–positron storage rings of the next generation (beam energy 2–3 GeV, luminosity $\sim 10^{32}$ cm^{-2} sec^{-1}). (auth)

13600 SIMPLE PARTON DUAL-RESONANCE MODEL FOR ELECTROPRODUCTION AND LEPTON-PAIR ANNIHILATION PROCESSES WITH THE INCORPORATION OF FINAL-STATE INTERACTION. Yu, Loh-ping (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 9, 2775-85(1 Nov 1971).

A new convergent, nonperturbative parton (straton) dual-resonance model for deep-inelastic eN and high-energy e^+e^- production processes is proposed. The model incorporates the parton's final-state interaction effects and resolves the puzzle why the parton is not observed experimentally. It does not require a "cutoff" of any sort, and automatically furnishes explicit formulas for the structure functions νW_2 and W_1 over the whole range of the scaling variable ω between 0 and ∞. The explicit formula for νW_2, apart from a nonscaling factor of $\ln^{-1}|q^2|$, correctly reproduces the Regge limit ($\omega \to \infty$), the "fixed-angle" limits ($\omega \to 1 \pm \epsilon$, ϵ finite), and the threshold behaviors ($\omega \to 1^+$) in connection with the asymptotic nucleon form factors. For the e^+e^- annihilation process, it further predicts the pionization (nucleonization) limit as $\omega \to 0$. It is also suggested that the final-state interaction is of the diffractive type (Pomeranchukon exchange); and it breaks the scaling law by the factor $(a + b \ln|q^2|)^{-1}$. (auth)

13601 SCALING LAWS IN HIGH-ENERGY PHYSICS. Preparata, G. (Univ., Rome. Brookhaven National Lab., Upton, N. Y.). Riv. Nuovo Cim.; 1: No. 3, 423-43(Jul-Sep 1971).

A general survey is given of physics with the aid of the light-cone expansions of products of local operators. Among the topics discussed are deep inelastic electron–proton scattering, massive muon pair production, and light-cone controlled mass dispersion relations. (J.F.P.)

13602 PARTON MODEL AND THE CONTRIBUTION OF RESONANCES IN THE DEEP INELASTIC ELECTRON–PROTON SCATTERING. Bandyopadhyay, P. (Indian Statistical Inst., Calcutta); Chaudhuri, P. Ray; De, S. S. Lett. Nuovo Cim.; 3: No. 1, 43-7(1 Jan 1972).

It is shown that one can have a model for partons consistent with the present experimental data in which the number of partons participating in the deep inelastic scattering is finite and there is practically no contribution from the cloud. The model gives a direct support to the conjecture of Bloom and Gilman (SLAC-PUB-779) that resonances do contribute to the scaling behavior and there is no diffractive contribution in the scaling-limit curve. A five-parton model is considered for deep inelastic electron–proton scattering. (J.F.P.)

13603 AGE DISTRIBUTION OF VERTICAL AND HORIZONTAL AIR SHOWERS. Sitte, K. (CNR, Turin. Univ., Freiburg i. B.). Lett. Nuovo Cim.; 3: No. 1, 25-9(1 Jan 1972).

A study is made of the age distribution of the showers recorded for a given shower size. Results are presented which are calculated for electromagnetic cascades, but it is noted that they are equal in the essential points to those valid for a mixed cascade of nucleonic origin. (J.F.P.)

13604 WATSON THEOREM FOR THREE-PARTICLE FINAL STATES. Goradia, Yogendra Narandas. Eugene, Oreg.; Univ. of Oregon (1971). 147p. University Microfilms Order No. 72-925.

Thesis.

The Watson theorem for the single pion photoproduction process relates the phase of the photo amplitude to the phase shift of the pion–nucleon scattering amplitude. The present investigation extends the theorem to include the double pion photo processes. After a brief review of the subject, several possible representations for the description of three-particle final states are examined. The representation suggested by Branson, Landshoff and Taylor which is in terms of the Euler angles of the triangle formed by the three momenta is chosen. For the two-particle initial states the helicity representation of Jacob and Wick is used. Then, using this framework, the extended theorem is derived. The derivation is solely based upon the known conservation laws and certain invariance properties of the S-matrix. A number of approximations can be made to simplify the exact theorem which is somewhat complicated. The theorem in its approximate form involves five real quantities, namely, the amplitude for $\gamma N \to N\pi$, the amplitude for $\pi N \to N\pi$, and the absolute value of the amplitude for $\gamma N \to N\pi\pi$. Since the amplitudes for the first two reactions are now available, the theorem was applied to calculate the absolute values of the amplitudes for $\gamma N \to N\pi\pi$ for various values of J, P, T, E. Since no dynamical models are assumed, the theorem is quite general and can be applied to other similar situations in particle theory as well as nuclear physics. The main difference between the present result and the previous ones obtained by others is that the detailed structure of the three-particle contribution to the phase relation is clearly indicated. Because of this the theorem

will continue to be useful in relating the three-body channels to the two-body channels as increasing amount of experimental information on three-body final states becomes available. (Diss. Abstr. Int., B)

13605 PERTURBATION-THEORETIC STUDY OF OSCILLATIONS IN SPECTRAL FUNCTIONS: THE FORWARD PION-VIRTUAL PHOTON SCATTERING AMPLITUDE. Acharya, Sarbeswar. College Park, Md.; Univ. of Maryland (1971). 98p. University Microfilms Order No. 72-1659.

Thesis.

It has been suggested that the divergence difficulties encountered in calculations of electromagnetic-mass difference of hadrons based on current algebra might be avoidable if the spectral functions associated with forward hadron-virtual photon scattering amplitudes changed sign infinitely often. Defining $\rho(q^2,\nu,p^2)$ = $Disc_{q^2} A(q^2,\nu,p^2)$ with $\nu = pq$ and $A(q^2,\nu,p^2)$ the amplitude for forward scattering of off-shell photons of momentum q from the pions of momentum p the question of sign changes of $\rho(q^2,\nu,p^2)$ was studied in perturbation theory, with ν and p^2 held fixed at some real values. The study was confined to second order in electromagnetic and second order in strong interactions and therefore the contributing Feynman diagrams involving four propagators only were considered. The work was done largely in two models: a model in which one of the four internal masses in the diagrams is much greater than the other three which are assumed to be equal. The singled-out mass interacts only strongly and others interact both strongly and electromagnetically, another model in which all four internal masses are equal. Two parallel sets of diagrams were considered—one set involving scalar (spinless) photons, and the other set involving photons with spin—and computed the spectral function for each set. The investigation shows there are some sign changes of the spectral functions, as the above mentioned speculation would suggest, in the order e^2g^2. However, the occurrence and location of such sign changes strongly depend upon the model one uses concerning the relative values of the internal masses, inclusion or exclusion of photon's spin, and whether the pion momentum is extrapolated to zero or not. As a by-product of the investigation the q^2-analyticity properties of the box diagram, with zero momentum transfer, on the physical sheet of the complex q^2-plane were established on which it was shown that there are only normal singularities. It was also pointed out that the spectral function in q^2 with ν(and p^2) fixed is different from that in ν with q^2 (and p^2) fixed. This conclusion is different from that reached previously. (Diss. Abstr. Int., B)

13606 MULTICHANNEL ANALYSIS OF PHOTOPRODUCTION IN THE RESONANCE REGION. Campbell, Robert Russell. Irvine, Calif.; Univ. of California (1971). 121p. University Microfilms Order No. 72-2236.

Thesis.

The first comprehensive multichannel analysis of photoproduction in the region of the first resonance is introduced. Rescattering dominance by the strong interaction enables one to solve the photoproduction problem with only a twofold input: a partial wave phenomenological parameterization of the strong πN scattering amplitude within the multichannel ND^{-1} framework, and the photoproduction Born approximations for the corresponding two body or quasi two body πN channels. Preliminary ND^{-1} solutions for πN scattering have recently become available, although they are somewhat lacking for the S11 partial wave. The photoproduction Born terms for the πN channel are the direct channel nucleon pole, the t channel pion pole, and nucleon and delta exchange. The Born terms for higher channels are assumed to be proportional to the higher channel strong Born terms, the proportionality constants being free parameters which are fitted either by comparison to the photoproduction resonances from higher energy isobar analyses or by direct comparison to the differential cross section data. In total there are twelve parameters, one for each multipole leading to one of the following πN partial waves: S11, S31, P11, P31, P33 and D13. A multichannel dispersion approach is needed because previous dispersion relation calculations can neither estimate contributions from transitions to the strongly inelastic πN partial waves S11, P11 and D13, nor be extended into the second resonance region. With a few exceptions the results of this preliminary analysis fit the differential cross sections better than these previous dispersion calculations. Thus, the multichannel approach is quite promising, and it is believed that when the strong ND^{-1} solutions can be parameterized so as to fit both elastic and inelastic πN processes, the photoproduction calculations should yield excellent results for $\gamma N \rightarrow 2\pi N$ as well as $\gamma N \rightarrow \pi N$. (Diss. Abstr. Int., B)

13607 ROLE OF $\gamma + \gamma \rightarrow e^+ + e^- + e^+ + e^-$ IN THE HIGH ENERGY CROSS SECTION FOR $\gamma + Z \rightarrow Z + e^+ + e^- + e^+ + e^-$. Brown, R. W. (Case Western Univ., Cleveland); Muzinich, I. J.; Roe, B. P.; Yao, York-pend. Phys. Rev. Lett.; 28: No. 2, 123-6(10 Jan 1972).

The possibility that the interesting large high-energy cross section for $\gamma + \gamma \rightarrow e^+ + e^- + e^+ + e^-$ can be indirectly tested via the reaction $\gamma + Z \rightarrow Z + e^+ + e^- + e^+ + e^-$ is discussed. As a by-product, the background caused by the former process in the Primakoff–Stodolsky method for measuring the total photon–photon cross section into hadrons is shown to be substantially reduced beyond naive expectations. (auth)

13608 TWO-BODY PROBLEM IN CLASSICAL RELATIVISTIC ELECTRODYNAMICS. I. UNLIKE CHARGES. Kasher, John C. (Boston Coll., Chestnut Hill, Mass. Univ. of Nebraska, Omaha); Schwebel, Solomon L. Phys. Rev., D; 4: No. 10, 2956-62 (15 Nov 1971).

Two arbitrary, equal masses with arbitrary, equal (but opposite) charges are held at rest at a certain distance apart for their entire past history up until t = 0. They are then released, and fall together under their mutual attraction until they pass through one another. No radiation forces are added to the equations of motion. The exact analytic solution for the first part of the trajectory is provided, and, through an analysis of the problem, further relationships are derived that lead to a numerical solution on the computer for the rest of the trajectory, where retarded functions must be used. (auth)

13609 PHYSICAL AND FORMAL PRESENTATIONS OF DUAL THEORY OF ELECTROMAGNETIC CURRENTS. Manassah, Jamal T.; Matsuda, Satoshi (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 4: No. 10, 3062-81(15 Nov 1971).

A dynamical Lagrangian theory is proposed for the hadron with strong and electromagnetic interactions. A simple physical interpretation is given of the Lagrangian in the parton picture and its equivalence with the formal string formulation of the hadron is explicitly shown for both the free and interacting Lagrangians. The theory is gauge-invariant with a well-defined conserved current. (The low-energy theorem for currents holds.) The elastic and transition form factors are non-Gaussian and analytic with an infinite series of vector-meson poles. In the two-current channel the electromagnetic amplitude has fixed poles with the imaginary part satisfying rigorously the Dashen–Gell–Mann–Fubini sum rule. In the Bjorken limit the νW_2 scales and is saturated by narrow resonances. A dispersion relation for T_2 continues to hold in the scaling limit and the Gottfried sum rule for $\nu W_2(\omega)$ is exactly satisfied with the fixed-pole contribution. The hadronic amplitude obtained from the off-shell Compton amplitude is equal to a beta function. In the crossed channel the theory generates Regge poles with quantized intercepts which are degenerate with the vector-meson poles in the off-shell photon line which phenomenologically implies the ρ-f-A_2 degeneracy. More generally, hadronic vertices are projected explicitly out of the electromagnetic vertex through vector-meson poles and it is found that these vertices are dual and factorizable. (auth)

13610 LOW-ENERGY THEOREMS FOR PHOTO- AND ELECTROPION PRODUCTION AT THRESHOLD. Vainshtein, A. I.; Zakharov, V. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Nucl. Phys.; B36: No. 2, 589-604(1972).

Low-energy theorems for the cross sections of photo- and electroproduction of pions at threshold are obtained. The derivation of the theorems is based on the use of the PCAC hypothesis and on the expansion of the amplitudes in powers of k/m_{int}, q/m_{int} where k, q are pion and photon four-momenta and m_{int} is some internal mass. All the contributions up to and including those quadratic in these ratios are taken into account. Two new low-energy theorems are obtained for the photoproduction cross sections. Predictions for electroproduction cross sections are given and it is shown that expected accuracy of these predictions depends crucially on the value of electron momentum transfer squared k^2. For $k^2 \ll m_{int}^2$ the accuracy of the results obtained is higher than that of the calculations performed earlier. The possibility of determining pion and neutron radii through measuring electroproduction cross section and the cross section of reaction $\pi N \rightarrow Ne^+e^-$ is discussed. It is shown that the Born approximation which is currently used for this purpose is in fact inadequate to describe the amplitude and new model-independent formulas are presented which allow one in principle to determine the pion radius. (auth)

13611 NON-MINIMAL CURRENT IN CHIRAL LAGRANGIANS AND PION PHOTOPRODUCTION. II. Pantin, C. F. A. (Cambridge Univ., Eng.). Nucl. Phys.; B36: No. 2, 445-71(1972).

Non-minimal currents are constructed to describe nucleon anomalous moments, the γNN^* vertex and N^* electromagnetic moments and related effects in the chiral Lagrangian formation without upsetting current algebra and PCAC. The construction is applied to pion photoproduction. $\gamma N \rightarrow N\pi$ is calculated, in particular the N^* contribution. The threshold results for $\gamma N \rightarrow N^*\pi$ are

shown to be in agreement with experiment. $\gamma N \rightarrow \pi\pi N$ is discussed, and certain graphs are shown to dominate the cross section. (auth)

13612 SCALING IN THE PHOTON–PHOTON INTERACTION. Kingsley, R. L. (Cambridge Univ., Eng.). Nucl. Phys.; B36: No. 2, 575–88(1972).

Particular high-energy limits for the structure functions of the inclusive process e + e → e + e + hadrons are considered in a parton model, and shown to lead to a scaling-type behavior. (auth)

13613 SCALING IN A LADDER MODEL FOR EXCLUSIVE AND SEMI-INCLUSIVE ELECTROPRODUCTION. Dorren, J. D. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; B36: No. 2, 541–65(1972).

In the framework of the ϕ^3 ladder model the scaling behavior of exclusive electroproduction processes is studied. The same model is combined with Mueller's approach to inclusive processes in which one final state hadron is detected, in order to obtain predictions about the scaling properties of the structure functions appearing in electroproduction reactions of the type "γ" + b → c + X where γ is a virtual spacelike photon, b and c are hadrons and X is the missing mass. Each of the several asymptotic limits is considered. (auth)

13614 REMARKS ON THE VALIDITY OF THE COTTINGHAM FORMULA FOR ELECTROMAGNETIC MASS SHIFTS. Creutz, Michael; Sen, Siddhartha (Univ. of Maryland, College Park). Phys. Rev., D; 4: No. 10, 2984–8(15 Nov 1971).

The effect of Schwinger terms on the Wick rotation necessary to derive the Cottingham formula for electromagnetic mass shifts is discussed. A simple condition is given which allows a covariant and gauge-invariant virtual Compton scattering amplitude to be constructed on which the Wick rotation can be performed. (auth)

13615 NUCLEON COMPTON EFFECT AND SUM RULE FOR THE NUCLEON DIPOLE MOMENT. Lapidus, L. I.; Musakhanov, M. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 4, 774–82(Oct 1971). (In Russian).

Provided the P and T invariances are violated, the nucleon may have an electric dipole moment. In this situation, a combination of the low-energy theorem with dispersion relations for the Compton effect results in a sum rule for the nucleon dipole moment. (auth)

13616 MULTIPLE PION PRODUCTION IN EXPERIMENTS WITH COLLIDING ELECTRON–POSITRON BEAMS. Altukhov, A. M.; Khriplovich, I. B. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 14: No. 4, 783–7(Oct 1971). (In Russian).

Estimates for the cross sections of the processes $e^+ + e^- \rightarrow 3\pi, 4\pi$ are obtained that do not contradict the available experimental data at the energy of ~1.2 GeV, and explain the data in the energy interval 1.6 to 2 GeV in a natural way. (auth)

13617 ELECTRON–POSITRON CASCADE PROCESSES IN STRONG STATIONARY ELECTRIC FIELDS. Eidman, V. Ya. (Gorky Radiophysical Inst., USSR). Zh. Eksp. Teor. Fiz.; 61: No. 5, 1737–42(Nov 1971). (In Russian).

A cascade process is considered which occurs in a strong stationary electric field E_0 and which can be self-sustaining if the energy lost by the particles in pair production is compensated as a result of acceleration in a field E_0. The conditions for appearance of a periodic regime are considered. (auth)

13618 SOME ASPECTS OF ELECTROMAGNETIC INTERACTIONS OF HADRONS. Sarkar, R. N. Madras; Indian Inst. Technol. (1969).

Thesis.

The problem of the photoproduction of the eta meson using the dispersion theoretic technique was studied. The contributions from the nucleon and the various pion-nucleon resonances which are vital to this production process were incorporated. In the numerical calculations the coupling constant involved was estimated from the known experimental widths of the resonances. The results thus obtained for the differential and total cross section are in good agreement with the currently available experimental data. A brief calculation of the polarization of the recoil nucleon was presented. The above work was extended to the photoproduction reaction of the $\eta'(X^0)$-meson. It is found that in this case the exchange channel is of greater significance although the direct channel contributions from the third pion-nucleon resonance cannot be neglected. The total cross sections at different energies fit the experimental curve satisfactorily while the angular distribution of cross sections shows a forward peak. The calculations concerning the photoproduction of the phi-vector meson are given. This process is particularly important since, so far, several approaches in fitting its cross section data have given divergent results with unduly large values. The inclusion of the η and η'-mesons is obtained in the exchange channel, a fairly good fit to the experimental situation. The general ideas behind the particle-mixing hypothesis are presented. A critical study of the mixing mechanism is followed by certain simple calculation of decay widths and coupling parameters. The dynamical calculations of the magnetic moments of baryons using the dispersion relations are presented. In the present analysis, the full energy dependence of the photoproduction amplitude is included. The results show a remarkable improvement in the case of strange baryons. A better value for the proton magnetic moment that for the neutron is found to be suppressed is obtained. Hence the nucleon is treated separately with the inclusion of the additional contributions from the vector-meson exchange. The results thus achieved are observed to be quite close to the experimental values. (Indian Sci. Abstr.)

13619 KHURI–TREIMAN MODEL OF $\eta \rightarrow 3\pi$ AND $K \rightarrow 3\pi$ DECAYS. Graves-Morris, P. R. (Univ. of Kent, Canterbury, Eng.). Lett. Nuovo Cim.; 2: No. 24, 1231–5(11 Dec 1971).

A two-pole model of the I = 0 S-wave $\pi\pi$ scattering amplitude is incorporated into the Khuri–Treiman theory for $\eta \rightarrow 3\pi$ and $K \rightarrow 3\pi$ decays. Decay distributions for $\eta \rightarrow 3\pi$ are calculated, and a good fit to the data is obtained. (L.B.S.)

13620 IS THE PHOTON A GOLDSTONE PARTICLE? Sen, R. N.; Weil, C. (Technion-Israel Inst. of Tech., Haifa). Nuovo Cim.; 6A: No. 4, 581–93(21 Dec 1971).

The degenerate vacuum formalism is developed for spin-1 Goldstone particles with an indefinite metric. This formalism eliminates the ambiguities in the early treatments and shows that there is no inconsistency with Poincaré invariance. It is argued that if the photon were a Goldstone particle there would be observable consequences, such as apparent angular-momentum nonconservation and violation of the principle of detailed balance. (auth)

13621 MAGNETIC MOMENT OF A PARTICLE WITH ARBITRARY SPIN. Tumanov, V. S. (Moscow State Univ.). Teor. Mat. Fiz.; 9: No. 3, 388–97(Dec 1971). (In Russian).

The intrinsic magnetic moment of a particle with arbitrary spin is calculated. The calculation is based on using of matrix elements for projection spin operators and coefficients of the relativistic wave equations. The obtained value of the magnetic moment confirms the suggested earlier hypothesis by Belinfante. (auth)

13622 NUCLEON–NUCLEON POTENTIALS AND RESCATTERING CORRECTIONS IN INELASTIC ELECTRON–DEUTERON SCATTERING. Kocevar, P. (Univ., Graz). Acta Phys. Austr.; 33: No. 2, 195–203(1971).

A summary is given of work on rescattering corrections for inelastic electron–deuteron scattering using various nucleon–nucleon potentials and phase shifts. (J.F.P.)

13623 VENEZIANO MODEL AND PION PHOTOPRODUCTION. Bartl, A. (Univ., Tuebingen, Ger.). Acta Phys. Austr.; 33: No. 1, 83–8(1971).

Veneziano expressions are constructed for all invariant single-pion photoproduction amplitudes. (J.F.P.)

13624 EXPERIMENTAL METHOD FOR STUDYING PION–VECTOR-MESON ELASTIC-SCATTERING AMPLITUDES. Alexander, G.; Bar-Nir, I.; Grunhaus, J.; Levy, A. (Tel-Aviv Univ., Ramat-Aviv, Israel). Nuovo Cim.; 7A: No. 1, 1–8 (1 Jan 1972).

Within the framework of the vector-dominance model, a method for an experimental study of the energy dependence of the pion–vector-meson scattering amplitudes is proposed for the reaction $\gamma N \rightarrow \Delta V^0 \pi$. The method is based on an analysis of the moments of the spherical harmonics of the $\gamma\pi \rightarrow V^0\pi$ process. This analysis is attractive, in particular, in the case that s-channel helicity conservation can be assumed for the $V^0\pi$ scattering process where all the moments $\langle Y_l^m \rangle$ with $m \neq 0$ vanish. (auth)

13625 CLIFFORD NUMBERS, DIRAC, AND RELATIVISTIC HAMILTON–JACOBI EQUATIONS. Percus, Jerome K.; Petrakopoulos, Nikitas L. (New York Univ., N. Y.). Contract AT(30-1)-1480. J. Math. Phys. (N. Y.); 12: No. 12, 2516–20 (Dec 1971).

Conditions are established under which the Dirac equation for an electron in an electromagnetic field has an exact semiclassical solution. In other words, the phase is identified with a solution of the corresponding relativistic Hamilton–Jacobi equation and the spinor amplitude has no explicit dependence upon $\hbar$. The complete set of admissible fields is determined for one-dimensional and stationary three-dimensional systems, while an extensive class is indicated for the general time-dependent problem. (auth)

13626 COMMUTATORS NEAR THE LIGHT-CONE. II. SCALING FUNCTIONS AND THEIR ANALYTIC CONTINUATION TO THE ANNIHILATION REGION. Gatto, R. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Menotti, P. Nuovo Cim.; 7A. No. 1, 118-43(1 Jan 1972).

A concrete dynamical model is studied to obtain information on scaling and related problems. The role of O_4 expansion is pointed out, and the relation of scaling to small-distance behavior of interactions is made evident. Problems connected with gauge invariance are analyzed. The Schwinger-term sum rule for $F_L(\omega)$ is discussed in the presence of Regge subtractions. The problem of analytic continuation of scaling functions into the annihilation channel is examined in a simple approximation. (auth)

13627 INELASTIC ELECTRON–PROTON SCATTERING AND MASS PARTONS. Haberler, P. L. F. (Duke Univ., Durham, N. C.). Acta Phys. Austr.; 32: No. 3-4, 331-7(Mar 1970).

From the experimental indication of a very broad maximum in pW_2 around $\omega = 5$ a mean parton mass of approximately 180 MeV is deduced. This low mass of the partons is explained in the field theoretic framework of Drell, Levy, and Yan and on more general field theoretic grounds. (auth)

13628 HADRONIC INTERACTIONS OF ELECTRONS AND PHOTONS. Proceedings of the Eleventh Session of the Scottish Universities Summer School in Physics, 1970. Cumming, J.; Osborn, H. (eds). London; Academic Press (1971). 653p. £10.50.

Lectures presented at the eleventh session of the Scottish Universities summer school in physics, July–August 1970, are reproduced. Topics covered were; some recollections from the early days of particle physics, introduction to photoproduction and electroproduction, electromagnetic properties and interactions of particles in the SU(3) symmetry scheme and quark model, photoproduction and electroproduction in the resonance region, pion electroproduction at the P_{33} resonance, photonic couplings of resonances in the second and third resonance regions, electroproduction of the higher nucleon resonances, photoproduction and vector dominance, interaction of high-energy photons with nuclei as a test of vector-meson-dominance, pseudoscalar meson dominance in neutrino-nucleus reactions, theoretical interpretation of storage ring results and vector meson dominance, lepton hadron processes at high energy, a graphical way to investigate scaling, photoproduction, electroproduction, and hadron dynamics, electromagnetic mass differences. Three seminars given at the school were entitled: limiting distributions of fragments in the absence of pionization, a jet model for e^+e^- annihilation into pions, and a strong absorption model for photoproduction. (UK)

Weak

Refer also to abstracts 13506, 13802, and 13811.

13629 (JINR–P2-6129) NONLOCAL THEORY OF THE ELECTROMAGNETIC AND WEAK INTERACTIONS WITH W BOSONS. Alebastrov, V. A.; Efimov, G. V.; Sel'tser, Sh. Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 52p. (In Russian). Dep. NTIS (U. S. Sales Only).

The perturbation theory of the electromagnetic and weak interactions is considered in the framework of nonlocal theory. A hypothesis is proposed that the photon and neutrino fields are connected with the charged local fields of the electrons, muons and W-bosons in the nonlocal way. The definite intermediate regularization procedure is introduced that the S-matrix is finite, unitary, causal, gauge invariant in perturbation theory when regularization is moved off. The interaction Lagrangian contains no infinite counter terms and the S-matrix is finite without any infinite renormalizations. (auth)

13630 (LBL–500, pp 145-52) WEAK NEUTRAL CURRENTS AND POLARIZATION EFFECTS IN HIGH-ENERGY LEPTON–PROTON SCATTERING. Winternitz, P. (Pittsburgh Univ., Pa. Dept. of Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

It is suggested that polarization phenomena in high-energy elastic muon–proton scattering should be investigated, since the presence of parity-violating experimental quantities would give model-independent information on the existence of weak neutral currents. The complications due to the initial fixed polarization of the muon beam are discussed; and several relevant experimental quantities are suggested and estimated to be of the order of 5% of the parity-conserving ones, if the weak neutral coupling constant G_N is equal to the Fermi constant G. All experiments of interest require a polarized proton target. (auth)

13631 (TID–25874, pp 355-68) THEORETICAL EXPECTATIONS FOR INELASTIC NEUTRINO–NUCLEON INTERACTIONS. Paschos, Emmanuel A. (Rockfeller Univ., New York). 1970.

In 1970 summer study.

The contributions of the three structure functions to the double differential cross section for a realistic NAL neutrino spectrum and reasonable theoretical assumptions are estimated. If $\sigma_s \approx 0$, in most of the models the form factors $F_2(x)$ and $F_3(x)$ are separable. The theoretical predictions that can be tested with this new experimental information are discussed. Most of the theoretical predictions, besides relations among the total cross sections, are sum rules. Most of the sum rules valid in the deep inelastic region are testable, provided that they saturate below 200 GeV. The sum rules, their saturation properties, and relevant references are summarized. (auth)

13632 RADIATIVE CORRECTIONS TO THE MUON POLARIZATION IN $K^{\pm}_{\mu 3}$ DECAYS. Ginsberg, Edw. S. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 9, 2893-2901 (1 Nov 1971).

Radiative corrections to the muon polarization vector in $K^{\pm}_{\mu 3}$ decays were calculated. The model, previously used, is based on a phenomenological weak $K-\pi$ vertex and perturbation theory. The answer depends logarithmically on a cutoff, although the corrections are not nearly as sensitive to variations in the cutoff as those for unpolarized decays. All terms which contribute to order α have been retained, with no approximations concerning the smallness of the muon mass or the "real" inner bremsstrahlung. The corrections to the three components of the polarization vector (longitudinal, transverse, and perpendicular) were evaluated numerically at points in the Dalitz plot, for various complex values of ξ. In addition, the integrated correction to the degree of polarization as a function of muon energy was also computed. It is found that these corrections are small, generally less than or equal to 1%, except in kinematically queer regions, where their relative size can be appreciable. (auth)

13633 WEAK-ELECTROMAGNETIC K-MESON DECAYS. Sarraga, R. F.; Munczek, H. J. (Univ. of Kansas, Lawrence). Phys. Rev., D; 4: No. 9, 2884-92(1 Nov 1971).

The contributions of the combined first-order-weak plus higher-order-electromagnetic effects to several K-meson decays are discussed. It is shown that if one uses a chiral $SU(3) \times SU(3)$ pole model to explain both $K_S \to 2\pi$ and $K_L \to 2\gamma$ one needs an effective nonleptonic interaction Lagrangian which contains 8 and 27, $\Delta I = \frac{1}{2}$ pieces. This gives results for $K^+ \to \pi^+ l\bar{l}$ compatible with the experimental data. The real part of the $K_L \to l\bar{l}$ amplitude is also calculated within this model, which results in a very small contribution to the decay rate. (auth)

13634 STRONG ISOSPIN BREAKING AND NONLEPTONIC K DECAYS. Bace, Marjan (Univ. of Rochester, N. Y.). Phys. Rev., D; 4: No. 9, 2838-43(1 Nov 1971).

Assuming (a) an exactly $|\Delta I| = \frac{1}{2}$ weak Lagrangian and (b) the existence of an isospin-breaking term, $\epsilon_3 u_3$, in the strong Hamiltonian, the ratios of reduced decay rates for $K \to 3\pi$ and $K \to 2\pi$ decays, observed experimentally to vary from the $\Delta I = \frac{1}{2}$ predictions by ~10%, are well explained if $\epsilon_3 \sim 0.05$. Rare K-decay modes involving two photons are estimated. (auth)

13635 THREE-PION INTERMEDIATE STATE AND THE $K^0_L \to \mu^+\mu^-$ PUZZLE. Aviv, R.; Sawyer, R. F. (Univ. of California, Santa Barbara). Phys. Rev., D; 4: No. 9, 2740-2(1 Nov 1971).

Soft-pion methods are used to derive an upper bound for the contribution of the 3π intermediate state to the imaginary part of the amplitude for $K^0_L \to \mu^+ + \mu^-$ in terms of the experimental upper bound for the decay rate, $\pi^0 \to e^+e^-$. The numerical result obtained is insufficient to reduce significantly the (too-large) imaginary part coming from the 2γ state; that is, insufficient to resolve the $K^0_L \to \mu^+\mu^-$ puzzle. (auth)

13636 AMBIGUITY IN SOFT-PION LIMIT AND TIME–SPACE EQUAL-TIME COMMUTATORS OF CURRENTS. Katz, J.; Sugawara, M. (Purdue Univ., Lafayette, Ind.). Lett. Nuovo Cim.; 3: No. 1, 5-8(1 Jan 1972).

The elimination of an ambiguity is discussed which arises in the soft-pion limit for the weak and electromagnetic matrix elements of hadrons because these matrix elements involve currents rather than their divergences. It is shown that this elimination requires that the equal-time commutator between the time component of an axial vector current and the space component of a current consists not only of the space component of a current and the Schwinger term but also of an additional term proportional to a δ function. This modification eliminates the difficulties found in decays such as $\pi^0 \to 2\gamma$, $\eta \to 3\pi$, and $K \to \pi + l + \nu$. (J.F.P.)

13637 PRODUCTION MODEL FOR DEEP-INELASTIC LEPTON SCATTERING: THE QUESTION OF MULTIPLICITIES.

Griffith, Richard W. (Argonne National Lab., Ill.). Phys. Rev., D; 4: No. 10, 3162-77(15 Nov 1971).

An equation is constructed for a structure function $A(s,t = 0;Q^2)$ in a model of inelastic lepton production which embodies (i) factorizability of secondary hadron emissions and (ii) a diffractive unitarity relation above a certain threshold for diffraction, $s = s_c(Q^2)$. Large-energy expressions are then abstracted for the leading behavior of the mean multiplicity $\bar{n}$, the total cross section, and for the recursive partial cross sections in terms of special functions. The growing behavior, $\bar{n} \sim g_0^2 \ln(s/s_0) = g_0^2 \ln(\rho Q^2/s_0)$ for large $s > s_c(Q^2)$ with either fixed Q^2 and increasing s, or large fixed $\rho \equiv s/Q^2$ and increasing Q^2, where $g_0^2 \sim O(1)$ and s_0 is a scale factor. Within specified assumptions of the model, amplitude A for $s > s_c$ scales in s/Q^2 up to a gentle logarithmic-type factor. This scaling behavior is concomitant with partial production amplitudes A_n which decrease with only an inverse power of $x \equiv \ln(s/s_0)$. For $s \leq s_c$, amplitude A tends to an exact scaled limit. An integral equation is obtained for the character $\hat{\sigma}(x)$ which determines the nature of the leading J-plane singularity-the position, by assumption, is located at $J = \alpha(0) \equiv 1$. This equation is a linear, Volterra integral equation involving the convolution product with a displacement kernel in the variable x. The inhomogeneous term consists of the diffractive (quasi-), elastic unitarity relation and of a "low-energy" moment integral in the amplitude A for $s \leq s_c$. (auth)

13638 EFFECT OF FINAL STATE INTERACTIONS AND DEUTERON BINDING IN $\nu d \rightarrow \mu^- pp$. Singh, S. K. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Phys.; B36: No. 2, 419-35(1972).

The elastic neutrino scattering on deuterium $\nu d \rightarrow \mu^- pp$ is studied for moderate neutrino energies using the impulse approximation. The numerical results for the double differential cross sections $d^2\sigma/dq^2dE_\mu$ where q^2 is the four momentum transfer squared and E_μ is the muon energy are presented. The effect of final state interactions is discussed using the two-nucleon continuum wave function derived from the Reid potential with a hard core and a Hulthèn wave function for the deuteron. The differential cross section $d\sigma/dq^2$ is also calculated and compared with the results obtained in the closure approximation. The effect of more realistic deuteron wave functions on the differential cross section $d\sigma/dq^2$ is also discussed in the closure approximation. (auth)

13639 NON-LOCAL WEAK CURRENT CURRENT COUPLING AND THE DECAY $K_1^0 \rightarrow \mu^+\mu^-$. Kuehnelt, H. (Univ., Karlsruhe, Ger.); Pietschmann, H. Nucl. Phys.; B36: No. 2, 615-20(1972).

The most general non-local weak Hamiltonian with unaltered currents is used to calculate the decay $K_1^0 \rightarrow \mu^+\mu^-$. With non-locality caused by a phenomenological "dipole fit," the calculation is finite and leads to a dipole mass less than or about 10 GeV. (auth)

13640 RADIATIVE HYPERON DECAYS AS A TEST OF NON-LEPTONIC WEAK-INTERACTION MODELS. Gaillard, M. K. (CERN, Geneva. Laboratoire de Physique Theorique et Particules Elementaires, Orsay, France). Nuovo Cim.; 6A: No. 4, 559-75(21 Dec 1971).

Decays of the type $B \rightarrow B' + \gamma$ with $|\Delta S| = 1$ are discussed as a means of studying the weak-mass transition. Only transitions involving neutral hyperons are sensitive to this term. Also the direct-emission amplitudes are discussed in relation to models of nonleptonic weak interactions. (auth)

13641 DISPERSION APPROACH TO INVESTIGATION OF WEAK NUCLEON–NUCLEON INTERACTIONS. Danilov, G. S. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 14: No. 4, 788-99(Oct 1971). (In Russian).

The dispersion method is proposed to calculate the parameters characterizing the P-odd part of the nucleon–nucleon amplitude. The given parameters are expressed through the NN-scattering phase shifts and the meson–nucleon coupling constants. With conventional hypotheses on the value of the given coupling constants, the value of the circular polarization P and of the asymmetry α of the γ quanta emission relative to the neutron spin in the reaction $n + p \rightarrow d + \gamma$ is found to be $|P| = 1.81 \cdot 10^{-8}$; $|\alpha| = 4 \cdot (10^{-8})$. (auth)

13642 SECONDARY-PARTICLE PRODUCTION IN HIGH-ENERGY MUON–NUCLEON INELASTIC SCATTERING AND HYPOTHESIS OF LIMITING FRAGMENTATION. Michel, B.; Montret, J. C. (Univ., Clermont, France). Lett. Nuovo Cim.; 2: No. 24, 1265-70(11 Dec 1971).

The hypothesis of limiting fragmentation is applied to charged particle production in muon inelastic scattering by nucleons in nuclear emulsion at 6 and 12 GeV. Experimental distributions and multiplicities support the hypothesis. (L.B.S.)

13643 SELF-COUPLING OF WEAK LEPTON CURRENTS IN HIGH-ENERGY NEUTRINO AND MUON REACTIONS. Fujikawa, Kazuo (Princeton Univ., N. J. Univ. of Chicago). Ann. Phys. (N. Y.); 68: No. 1, 102-62(Nov 1971).

The detailed numerical analysis of the weak leptonic processes $\nu + (Z) \rightarrow \nu + \mu + \bar{\mu} + (Z)$ and $\bar{\mu} + (Z) \rightarrow \bar{\mu} + \nu + \bar{\nu} + (Z)$ was performed based on the conventional V−A Fermi theory. Marked asymmetry was found between μ and $\bar{\mu}$ in the first reaction. The muon is more energetic and appears more in the forward direction compared with the antimuon. The invariant mass of the $\mu\bar{\mu}$ pair is found to be small. The antimuon in the second process loses almost all its energy during the reaction. The asymptotic formula at extremely high energy is also derived. The ratio of the total cross sections for these two processes at high energy is discussed. The effects of the deeply inelastic process on these reactions are also discussed. A rather detailed phase space reduction is presented. (auth)

13644 ARE NEUTRINOS STABLE PARTICLES? Bahcall, John N.; Cabibbo, Nicola; Yahil, Amos (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett.; 28: No. 5, 316-18(31 Jan 1972).

It is pointed out that neutrinos with a finite mass could be unstable. The consequences of this possibility for solar-neutrino experiments are discussed. (auth)

13645 DEEP INELASTIC NEUTRINO-SCATTERING. Grosse, H. (Univ., Vienna). Acta Phys. Austr.; 33: No. 2, 97-114(1971).

The kinematics of the process will be discussed first, and two different covariant expansions of the hadronic tensor are given. Using PCAC it is possible to relate one structure function (W_2) to the total pion–nucleon absorption cross section. Then the Regge analysis is made using helicity amplitudes and "derivative amplitudes;" it gives the asymptotic behavior of the functions W_i for large r. By requiring the scaling behavior, the Bjorken limit is studied with two model independent methods. First by using the so-called DGS-representation for causal functions, and second by examining the leading light cone singularity in configuration space. The same structure is obtained by applying the light cone expansion of $J_\mu(x)J_\nu(0)$. For $W_{1,A}^+$ it is found that the residuum of the Gell-Mann J = 1 fixed pole is independent of momentum transfer. Furthermore the residuum functions are related to the structure functions in the Bjorken limit, which makes it possible to compare some numerical estimates. A sum rule for F_3^+ is derived which gives in its integrated form a known relation. (auth)

13646 PRODUCT EXPANSIONS OF OPERATORS, CVC, AND A RENORMALIZABLE THEORY OF WEAK INTERACTIONS. Kummer, W. (Technische Hochschule, Vienna). Acta Phys. Austr.; 32: No. 3-4, 387-94(Mar 1970).

The renormalizable theory of weak interactions, proposed some time ago by G. Segrè and the author, seemed to encounter certain difficulties, if the experimentally successful hypothesis of a conserved hadronic vector current (CVC) was to be incorporated. The recently developed expansion of operator products offers now a consistent way to understand CVC also in terms of this model for those cases, where the external momenta of the process are small compared to the (large) internal mass, describing the nonlocality. One can predict qualitatively deviations of order E/M, where E is the energy in high energy neutrino reactions, if this picture of weak interactions should turn out to be correct. (auth)

13647 DIRECT PARTICLE THEORY OF WEAK INTERACTIONS. Hoyle, F.; Narlikar, J. V. (Cambridge, Univ., Eng.). Nuovo Cim.; 7A: No. 1, 262-70(1 Jan 1972).

A theory of weak interactions is developed in terms of direct particle action. In its simplest form the theory leads to the formulation given by Feynman and Gell-Mann. (auth)

Strong (General)

Refer also to abstract 13776.

13648 (INP–771) DISTRIBUTION OF TRANSVERSE MOMENTA AND THE ENERGY SPECTRA OF MESONS FOR THE DEFINITE FUNCTIONS OF MOMENTUM DISTRIBUTIONS IN THE CENTRE-OF-EMISSION SYSTEM IN THE RANGE OF ENERGY OF INTERACTING PARTICLE > 10^{12} eV. Niziol, B. (Institute of Nuclear Physics, Krakow (Poland)). Sep 1971. 11p. Dep. NTIS (U. S. Sales Only).

The distributions of transverse momenta and the energy spectra of mesons in the laboratory system are presented. These distributions were calculated for the experimentally best justified momentum distributions in the center-of-emission system. (auth)

13649 (JINR–P2-6115) BOGOLYUBOV TRANSFORMATION IN THE STRONG COUPLING THEORY. II. Solodovnikova, E. P.;

Tavkhelidze, A. N.; Khrustalev, O. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 26p. (In Russian). Dep. NTIS (U. S. Sales Only).

The Bogolyubov transformation is generalized for the case of strong interaction of particles with the field invariant with respect to the arbitrary continuous group of transformations. (auth)

13650 (NP-19156) HIGH ENERGY REACTIONS. Schmitz, N. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). [1970]. 143p. Dep. NTIS (U. S. Sales Only).

Lectures on the Regge pole model for elastic and inelastic two-body strong interactions are presented. The kinematics, characteristic properties of the experimental data, the Regge pole model for particles with and without spin, total cross sections, meson exchange in high-energy forward scattering, baryon exchange in high-energy backward scattering, difficulties with the Regge pole model, and Regge cuts are covered. (J.F.P.)

13651 CONSEQUENCES OF RELATIVISTIC QUARK MODELS FOR THE INTERACTIONS OF HADRONS. Dias de Deus, J. (Univ. Coll., London). Phys. Rev., D; 4: No. 9, 2858-65(1 Nov 1971).

Hadron interactions are formulated in terms of relativistic quark models. The constraints of vector-meson dominance and partial conservation of axial-vector current are used to select convenient quark-quark-meson vertex functions. These vertex functions correspond to Llewellyn Smith's model I. Interactions of hadrons are assumed to take place through quark interactions, and coupling constants are evaluated using quark graphs. The results are consistent with vector-meson-dominance and the $\phi-\omega$ current-mixing model. Deviations from SU(3) and the nonrelativistic additivity quark model are predicted. (auth)

13652 BOUNDS FOR THE LINEAR COMBINATIONS OF STATISTICAL TENSORS. Kotanski, A. (Jagellonian Univ., Krakow); Sredniawa, B.; Zalewski, K. Acta Phys. Pol.; B2: No. 6, 789-92(Nov-Dec 1971).

A method of estimating the physical bounds for the linear combinations of components of statistical tensors is presented. Numerical values of the bounds for tensor combinations appearing in the additive quark model predictions for resonance production in two-body processes are calculated. (auth)

13653 LEE MODEL WITH ADDITIONAL FERMI INTERACTION AND THE COMPOSITE NATURE OF V-PARTICLE. Lukierski, J.; Turko, L. (Univ., Wroclaw). Acta Phys. Pol.; B2: No. 6, 741-52(Nov-Dec 1971).

The generalized Lee model with additional nonlocal four-leg $N\Theta-N\Theta$ vertex is studied. The lowest sector is solved for arbitrary choice of the cut-off functions in both vertices. A complete discussion of the $Z_1 = Z_V = 0$ limit, defining the composite V-particle, is presented. (auth)

13654 DISTRIBUTION OF THE SPINS OF THE RESONANCES IN THE DUAL-RESONANCE MODEL. Chiu, C. B. (California Inst. of Tech., Pasadena); Heimann, R. L.; Schwimmer, A. Phys. Rev., D; 4: No. 10, 3177-83(15 Nov 1971).

Quantum-statistical mechanics is used to calculate the distribution of the spins of the resonances in the dual-resonance model at a fixed high energy squared (s). The resonances are concentrated in the region of spin $\approx\sqrt{s}$, with the distribution eventually falling off exponentially. The profile function of the Veneziano partial-wave amplitudes is mainly controlled by the spin distribution of the resonances, and not by their individual couplings. This spin distribution is largely similar to that in the statistical model of nuclei. (auth)

13655 ANALYTIC STRUCTURE OF THE TRIPLE-REGGE VERTEX. DeTar, C. E.; Weis, J. H. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 10, 3141-61(15 Nov 1971).

The triple-Regge, helicity-pole and related asymptotic behaviors of the six-line amplitude are studied using the dual-resonance model (DRM) as a guide. It is shown that the triple-Regge vertex in the (DRM) can be expressed as a sum of four terms, which is interpreted as exhibiting the allowed tree-like configurations of singularities in the asymptotic channel invariants. These four terms have counterparts in the helicity-pole limit where there exist several distinct terms with differing powers of the asymptotic variable, i.e., several different helicity poles. As an application the interesting property of the (DRM) that the triple-Regge or helicity-pole contribution to single-particle production at zero momentum transfer vanishes for trajectory intercepts near unity is investigated. This effect is traced to a nonsense zero. This suggests a mechanism for fulfilling one of the unitarity requirements for general six-line amplitudes. The possible generality of the results is discussed. (auth)

13656 FIXED AND REGGE POLES IN THE VIRASORO MODEL. Kennedy, W. L.; Oh, C. H. (Univ. of Otago, Dunedin, New Zealand). Phys. Rev., D; 4: No. 10, 3224-5(15 Nov 1971).

Closed-form expressions are given both for the residues $\bar{\beta}_p(s)$ of the Regge poles at $l = \alpha(s) - p$ and for the residues $\beta_p(s)$ of the fixed poles at $l = -p-1$, $p = 0,1,2,\ldots$. It is noted that $\beta_p(s)$ should vanish for p odd integral if the Regge trajectories are spaced by two units of angular momentum. (auth)

13657 TWO FACES OF A DUAL PION-QUARK MODEL. II. FERMIONS AND OTHER THINGS. Halpern, M. B.; Thorn, C. B. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 10, 3084-8(15 Nov 1971).

In the first paper of this title, a dual pion model was shown to be equivalent to the pion sector of the dual quark model. Here it is established that the fermions are also the same. In addition, it is shown that the Neveu-Schwarz model is a dual quark model with a particular spin-spin interaction, and the fermions of the "Pomeranchon-pion" model are given. (auth)

13658 DUAL-RESONANCE-MODEL IMPLICATIONS FOR TWO-PARTICLE SPECTRA IN INCLUSIVE REACTIONS. Hasslacher, B.; Hsue, C. S.; Sinclair, D. K. (State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 10, 3089-98(15 Nov 1971).

Recent work on inclusive reactions in the dual-resonance model is extended by using Mueller's technique on the eight-point Veneziano amplitude. The inclusive two-particle spectrum is derived in various kinematic regions, and consistency checks are carried out. Factorization is shown in the multi-Regge region of $f_2(p_1,p_2)$ into $f_1^{(i)}(p_1)f_1^{(i)}(p_2)$, where $f_1^{(i)}(p)$ is the single-particle spectrum derived from the six-point function. The same universal cutoff in transverse momentum derived for the single-particle spectrum appears again here. In the central region an explicit form for $f_2(p_1,p_2)$ is obtained and asymptotic consistency with the multi-Regge region is shown. Some properties of the azimuthal dependence of $\vec{p}_\perp^{\,1} \cdot \vec{p}_\perp^{\,2}$ in the central region are derived. (auth)

13659 STATISTICAL BOOTSTRAP MODEL OF HADRONS WITH SPIN. Chiu, C. B.; Heimann, R. L. (California Inst. of Tech., Pasadena). Phys. Rev., D; 4: No. 10, 3184-3201(15 Nov 1971).

The statistical bootstrap model of hadrons is formulated so that it includes angular momentum. Several types of solutions that the bootstrap admits are studied. One self-consistent solution, which has a strong physical motivation founded within the model, has a spin (J) distribution of resonances at mass m in which most resonances occur below a J proportional to $\sqrt{m}$, the constant of proportionality being bounded by the other parameters of the model. There is then a whole set of solutions, that have J proportional to $(\sqrt{m})^\gamma$, where γ lies between 0 and 1. This set of solutions cannot be excluded within the accuracy used. A third class of solutions, very similar to the resonance spin spectrum of the Veneziano model are also found, in which most resonances occur below a spin proportional to m. Finally, a second solution to the bootstrap of the total level density was discovered. (auth)

13660 CLOSED LINEAR ALGEBRA OF CURRENTS AND BARYON INTERPOLATING FIELDS. Wise, Michael L. (State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 10, 3124-40(15 Nov 1971).

A closed linear algebra involving vector and axial-vector currents and baryon interpolating fields (BIF) is constructed. In particular, the equal-time anticommutator of two BIF is assumed to be the most general expression linear in currents allowed by covariance and the discrete symmetries. The algebra is closed via the various Jacobi identities. Whenever possible methods are used in analogy with successful current-algebra concepts. The basic BIF considered here has spin $\frac{1}{2}$ and is assumed to transform linearly under chiral SU(3). Its divergence can be used as a BIF for spin-$\frac{1}{2}$ baryons. A Lagrangian model combining the massive Yang-Mills gauge field ϕ^μ and the Rarita-Schwinger field Ψ^ν is constructed. The canonical commutation relations of such a model imply that the equal-time anticommutator $\{\Psi^0,\bar{\Psi}^\mu\}$ contains a term proportional to ϕ^μ. In a limiting case only this term remains. "Soft-baryon" theorems are derived from the algebra. In particular the s-wave scattering of "soft nucleons" from a target is calculated and agrees with the current-algebra soft-meson s-wave scattering lengths. Weinberg-like sum rules resulting from the algebra are also derived. (auth)

13661 SCALING LAWS IN THE STRONG INTERACTION AND IN THE ELECTROMAGNETIC INTERACTION OF HADRONS. Yu, Loh-ping (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 10, 3113-23(15 Nov 1971).

It is shown that, within the framework of the dual-resonance

models, it is possible to find one kind of scale transformation on the Chan variables which generates the Bjorken scaling law in deep-inelastic lepton-hadron scattering and the Feynman scaling law in hadronic inclusive reactions. Applying similar scale transformations to the exclusive production processes, it is shown that the invariant amplitudes, for both the lepton-hadron and the pure hadronic exclusive reactions, are not scaled, but that the nonscaled parts are factorizable from the scaled parts. It is then concluded that the hadronic cross sections at fixed multiplicities as well as the lepton-hadron structure functions at fixed multiplicities are not scaled in general, but that both fall off in the nonscaling variables. Consequently, the average multiplicities are necessarily divergent in general, and they favor lns distributions. (auth)

13662 THEORY OF A FIXED-POLE POMERANCHUKON BOOTSTRAP. Arnold, Richard C. (Argonne National Lab., Ill); Steinhoff, John. Phys. Rev., D; 4: No. 10, 3038-44(15 Nov 1971).

A self-consistent model of asymptotic high-energy hadron–hadron scattering determining the t dependence at small angles is formulated and compared with available experimental results. This model takes the Pomeranchuk singularity as a fixed pole, self-generating through unitarity in the s channel. The production mechanisms assumed to be most important in the elastic-scattering unitarity sum are those involving essentially the Pomeranchukon; they are "diffraction dissociation," or "strong bremsstrahlung" with the pion (as the lightest hadron) mass determining the scale for t dependences. In addition to pion propagators, a form factor which is required in the production model may be determined self-consistently by postulating a certain universality and the Chou–Yang hypothesis. Specific predictions for diffraction-peak widths at asymptotic energies are given and are in qualitative agreement with presently available data. (auth)

13663 SELF-CONSISTENT POMERANCHON COUPLING RATIOS IN THE MULTIPERIPHERAL MODEL. Abarbanel, H. D. I.; Chew, G. F.; Goldberger, M. L.; Saunders, L. M. (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 10, 2988-92 (15 Nov 1971).

Given the two leading eigenvalues and eigenfunctions of the resonance (low-subenergy) component of a multiperipheral kernel and assuming lower eigenvalues to be unimportant, it is shown how the mixture corresponding to the Pomeranchon eigenfunction may be calculated from considerations of self-consistency. The method is illustrated in a multiperipheral model with pseudoscalar-meson links by associating the two leading unperturbed eigenstates with the 2^+ particles f(1260) and f′(1514). (auth)

13664 SUMMING SOFT PIONS. II. STATISTICAL APPROACH TO UNITARITY DAMPING. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 10, 2993-7 (15 Nov 1971).

The effects of multiple-pion exchange in hard-hadron reactions are explored in a general chiral-invariant model, without neglect of multipion interactions or loops. It is found that the term in the S matrix belonging to the (N/2, N/2) representation of algebraic $SU(2) \times SU(2)$ is damped by a factor $D_N < 1$. For N going to infinity through even or odd values, D_N becomes proportional to $(N + 1)^{-1}$, with a remainder which vanishes rapidly as $N \to \infty$. It is suggested that when the ultraviolet cutoff on the virtual-pion momenta is allowed to go to infinity, the damping factors D_N approach zero for N odd and $1/(N + 1)$ for N even. As a consequence, hard-hadron reaction amplitudes may conserve a new multiplicative quantum number. (auth)

13665 BOOTSTRAP CONDITIONS FOR PHOTON INTERACTIONS. Capps, Richard H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 10, 2997-3005(15 Nov 1971).

A set of "bootstrap" self-consistency conditions, obtained previously for hadron–hadron scattering amplitudes, are generalized to amplitudes involving one external photon (defined here as any weakly interacting boson). The hadron–hadron bootstrap conditions are known to require that the mesons and baryons correspond to simple representations of one of the groups SU(n). The photon conditions require that the photon–meson–meson and photon–baryon–baryon interactions are a sum of two parts, one part transforming as a state of the regular representation of the group, the other transforming as a singlet. If the spin and parity of the photon are 1^-, this result is equivalent to vector dominance for these vertices. The experimental implications of the results are discussed briefly. (auth)

13666 LADDER AMPLITUDE AND ITS CLUSTER EXPANSION: A NEW APPROACH TO SUMMING DIAGRAMS. Chang, Shau-jin (Univ. of Illinois, Urbana); Yan, Tung-mow; Yao, York-peng. Phys. Rev., D; 4: No. 10, 3012-35(15 Nov 1971).

The t-channel ladder diagrams are used in a ϕ^3 theory up to tenth order in coupling constants as an example to study the possible connection between fragmentation and pionization and to suggest a new approach to summing diagrams. It is demonstrated that, at infinite energies, the nonleading logarithms are associated with the degrees of freedom in the longitudinal phase space of subsystems of two or more particles with small invariant mass, called the clusters, just as the leading logarithms are associated with the degrees of freedom in the longitudinal phase space of uncorrelated single particles. The sum of nonleading logarithms associated with each cluster also exponentiates to a power of s. The resultant s dependence of the full amplitude is the product of power dependences for individual clusters. In terms of fragmentation and pionization, it is found that the ladder amplitude factors into three parts, corresponding to fragmentation of the target, pionization, and fragmentation of the projectile. Including fragmentation events only modifies the scattering amplitude by an s-independent factor; all the s dependence is contained in the pionization part. (auth)

13667 RELATIVISTIC QUARK MODEL WITH HARMONIC DYNAMICS. Ravndal, Finn. Pasadena, Calif.; California Inst. of Tech. (1971). 122p. University Microfilms Order No. 72-484.

Thesis.

A relativistic equation to represent the symmetric quark model of hadrons with harmonic interaction is constructed. This gives straight and parallel Regge trajectories and a hadron spectrum which easily can accommodate all known resonances. From the equation vector and axial vector currents are derived for baryons and mesons. The vector current matrix elements of baryons are compared to known magnetic moments, photoproduction amplitudes and inelastic electron proton cross sections. Good agreement is obtained when the theoretical results are modified by an empirical form factor. Besides this form factor, the results depend on no free parameters. Using the same form factor, radiative decay rates of vector mesons and parameters of K_{l3} decay are calculated which agree fairly well with experiment. Assuming that the amplitude for emission of a pseudoscalar meson from a hadron is proportional to the divergence of the axial vector current, most of the known strong decay rates are calculated. These results depend on one new coupling constant and a smooth, empirical form factor. More than half of the calculated baryon rates agree well with experiment. The reasons for the many disagreements are discussed. All except one of the meson rates come out close to their experimental values. The angular distributions of the decay $B(1235) \to \omega\pi$ and $A_1(1070) \to \rho\pi$ are well described in this model. (Diss. Abstr. Int., B)

13668 ELIMINATION OF PARITY DOUBLETS IN REGGE AMPLITUDES. Kislinger, Mark Brecher. Pasadena, Calif.; California Inst. of Tech. (1971). 60p. University Microfilms Order No. 72-476.

Thesis.

The common belief that fermions lying on linear trajectories must have opposite-parity partners is shown to be false. Reggeization of a sequence of positive-parity fermion resonance is carried out in the Van Hove model. As a consequence of the absence of negative-parity states, the partial-wave amplitudes must have a fixed cut in the J plane. This fixed cut, in conjunction with the moving Regge pole, provides a new parametrization for fermion-exchange reactions, which is in qualitative agreement with the data. The spin structure of three-particle vertices is determined from the quark model. Using these $SU(6)_W$ vertices in the Van Hove model, a Reggeized scattering amplitude is derived. In addition to Regge poles there are necessarily fixed Regge cuts in both fermion and boson exchange amplitudes. These fixed cuts are similar to those found previously, and may be viewed as a consequence of the absence of parity doubled quarks. The magnitudes of the pole and cut terms in an entire class of SU(6) related reactions are determined by their magnitudes in a single reaction. As an example the observed presence or absence of wrong-signature nonsense dips in a class of reactions involving vector meson exchange is explained. (Diss. Abstr. Int., B)

13669 GAUGE INVARIANCE AND UNIQUENESS OF THE RENORMALISATION OF DUAL MODELS WITH UNIT INTERCEPT. Neveu, A.; Scherk, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B36: No. 2, 317-31(1972).

The consequences of gauge invariance for the unitarization and renormalization of dual models with unit intercept are re-examined in the light of the connection of those models with quantum electrodynamics and massless Yang–Mills fields. It is shown that the

arbitrary constant in the renormalization procedure must be interpreted, at least in order g^2, as a coupling constant and wave-function renormalization. The main consequence is the absence of renormalization of the intercept of the leading trajectory, which, at least in order g^2, and presumably to all orders, remains fixed at one. (auth)

13670 PRODUCTION CROSS SECTION OF HIGH-SPIN RESONANCES IN MISSING MASS EXPERIMENTS IN THE VENEZIANO MODEL. Tsou, Sheung Tsun (Univ., Geneva). Nucl. Phys.; B36: No. 2, 472-84(1972).

The generalized Veneziano model is applied to the study of production cross sections of high-spin resonances in missing mass experiments. Explicit calculations for resonances with $J \leq 21$ were carried out which show that: (i) the production cross section σ decreases rapidly as J increases, the value for J = 20 being merely $\sim 10^{-3}$ times the values for J = 1; (ii) as a function of s, σ rises slowly from threshold to a maximum, then falls as s further increases. The position of the maximum increases with J (for J = 19, e.g., $s_{max} \sim 100$ GeV^2); (iii) the differential cross section $d\sigma/dt$ is almost exponential in t with no dip in the forward direction. Although the results are qualitatively as expected, the numerical values are presented graphically in some detail in the hope that they may be useful to experimenters planning such experiments. (auth)

13671 AXIAL QUARK NUMBER AND THE η MESON. Fujii, Yasunori; Kitakado, Shinsaku (Tokyo Univ.). Nucl. Phys.; B36: No. 2, 512-18(1972).

It is shown in the framework of chiral Lagrangians that a concept of axial quark number is conveniently used in formulating a departure from a naive quark model of pseudoscalar mesons. Problems of the η are investigated from this point of view. (auth)

13672 LOWER BOUND FOR THE σ_{el}/σ_{tot} RATIO AT HIGH ENERGIES. Lukaszuk, L. (Inst. for Nuclear Research, Warsaw). Acta Phys. Pol.; B2: No. 6, 731-9(Nov-Dec 1971).

A new method for the derivation of the lower bound for the elastic-to-total cross-section ratio at high energies is presented. It is shown that the constant factor can be improved down to the latest value of the constant in the Froissart bound. (auth)

13673 CONTRIBUTION TO THE DECAY THEORY OF UNSTABLE QUANTUM SYSTEMS. II. Fonda, L. (International Centre for Theoretical Physics, Trieste, Italy. Univ., Trieste, Italy); Ghirardi, G. C. Nuovo Cim.; 6A: No. 4, 553-8(21 Dec 1971).

In the context of a proposed theory of decay two theorems, which are necessary in order to guarantee the physical consistency of the formalism, are proved. (auth)

13674 IMPROVED COUPLED INTEGRAL EQUATIONS FOR THE REGGE PARAMETERS. Abbe, W. J. (Univ. of Georgia, Athens). Nuovo Cim.; 6A: No. 4, 455-64(21 Dec 1971).

A method is given for improving the integral equations for the Regge parameters, given by Cheng and Sharp, and Frautschi, Kaus and Zachariasen. The multichannel, two-body unitarity relation is expanded in a Laurent-type expansion $a_{-1}(1-\alpha)^{-1} + a_0 + a_1(1-\alpha) + a_2(1-\alpha)^2 + \ldots$; satisfaction to any order in $(1-\alpha)$ may be achieved, with results in additional relations between the residue and trajectories and, therefore, a more complete set of integral equations. In this way exact satisfaction of unitarity may be obtained in principle. (auth)

13675 ASYMPTOTIC BEHAVIOR OF THE PARTIAL CROSS-SECTIONS. Caneschi, L. (CERN, Geneva). Lett. Nuovo Cim.; 2: No. 24, 1261-4(11 Dec 1971).

The relation between the logarithmic behavior of the average multiplicity of particles produced in high-energy interactions and the asymptotic vanishing of the partial cross sections is examined in the multiperipheral model. (L.B.S.)

13676 DIFFRACTIONAL HADRON SCATTERING AND THE EIKONAL APPROXIMATION. Andreev, I. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 14: No. 4, 837-48(Oct 1971). (In Russian).

Contribution from the eikonal-type processes to the high-energy hadron elastic scattering amplitude is studied. Energy and angular dependences of the amplitude and its value are considered as well as the effect of spin of the particles transferring the interaction. The conclusion is that the eikonal contribution is rather substantial at sufficiently high energies. (auth)

13677 SEARCH FOR QUARKS IN HIGH-ENERGY AIR SHOWERS. Boehm, A.; Diemont, W.; Faissner, H.; (and others) (Technische Hochschule, Aachen). Phys. Rev. Lett.; 28: No. 5, 326-9(31 Jan 1972).

Quarks of charge $\frac{1}{3}e$ and $\frac{2}{3}e$ were searched for in air showers of energies between 10^{13} and 10^{15} eV. A hodoscope of proportional counters was placed under 15 cm of Pb. Scintillation counters on top of the lead triggered on high-multiplicity showers. No quark was detected in 2120 h. The upper limit of the quark flux in showers between 10^{14} and 10^{15} eV is, with 90% confidence, 1.0×10^{-10} cm^{-2} sec^{-1} sr^{-1} for either charge. (auth)

13678 RELATIVISTIC SCALAR QUARK MODEL WITH STRONG BINDING. Boehm, M.; Joos, H.; Krammer, M. (DESY, Hamburg). Nuovo Cim.; 7A: No. 1, 21-46(1 Jan 1972).

The dynamics of strong binding of heavy scalar particles (quarks) are discussed with the help of the Bethe–Salpeter equation with a smooth ladder-type kernel. For this purpose, the Bethe–Salpeter amplitudes are expanded into O_4 spherical functions and the remaining "hyper-radial" equation is solved by a variational method. These calculations are considered as a model of mesons as bound states of heavy quarks. The low-lying mesons form linear trajectories with a slope of 1 (GeV)$^{-2}$. The modification of the vector–meson dominance form factor by the bound-state wave functions is calculated and found to be in good agreement with experiment. (auth)

13679 CALCULATION OF SECOND-ORDER VACUUM POLARIZATION ENERGIES FOR NONSPHERICAL HADRONIC ATOMS. Seki, Ryoichi (San Fernando Valley State Coll., Northridge, Calif.); Kunselman, Raymond. Amer. J. Phys.; 40: No. 1, 197-9(Jan 1972).

The second-order vacuum polarization energies are calculated for observable transitions in kaonic chlorine-17. (J.F.P.)

13680 INVERSE DECAY PROBLEM. Horwitz, L. P.; La-Vita, J. A.; Marchand, J.-P. (Univ. of Denver). J. Math. Phys. (N. Y.); 12: No. 12, 2537-43(Dec 1971).

Let $U_K(t)$ be a one-parameter operator family of positive type in a Hilbert space K and U(t) its minimal unitary dilation with infinitesimal generator H. If $U_K(t)$ is a contractive semigroup, then H is not positive. If in addition $U_K(t) \to 0$ for $t \to \infty$, then there exists a state $\phi \epsilon K$ on which H is not defined. These and other results are interpreted in the context of the quantum-mechanical theory of unstable particles and the scattering theory of Lax and Phillips. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 13528 and 14225.

13681 (JINR–E2-6144) ON THE $X^0(960)$ MESON SPIN PARITY DETERMINATION IN ANTIPROTON–PROTON ANNIHILATION AT REST. Genina, L. E.; Lednicky, R.; Zaslavskii, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1971. 10p. Dep. NTIS (U. S. Sales Only).

A method for $X^0(960)$ meson spin parity determination in $\bar{p}p$ annihilation at rest is suggested. Angular correlations which allow one to distinguish between the hypotheses $J^P(X^0) = 2^-$ and $J^P(X^0) = 0^-$ are obtained. (auth)

13682 VECTOR-DOMINANCE MODEL, PARTIAL CONSERVATION OF THE AXIAL-VECTOR CURRENT, AND THE DECOUPLING OF $\pi\rho\omega$. Mannheim, Philip D. (Univ., Brussels). Phys. Rev., D; 4: No. 9, 2936-40(1 Nov 1971).

It is shown that partial conservation of the axial-vector current and vector dominance together imply that $g_{\pi\rho\omega} = 0$. The relevance of this result to the failure of vector dominance in polarized photoproduction of pions is discussed. A simple interpretation of the ρ-meson mass shift in photoproduction experiments is provided based on unitarity. (auth)

13683 ANALYSES OF SPLIT RESONANCES. Coulter, Philip W.; Shaw, Gordon L. (Univ. of California, Irvine). Phys. Rev., D; 4: No. 9, 2919-21(1 Nov 1971).

Any definitive conclusion concerning whether the A_2 is split or not should be based not on the validity of the dipole hypothesis but on the possibility of the interference of two resonances. The constraints of unitarity on a multichannel amplitude with two overlapping resonances have been well studied; however, the simplicity and theoretical interpretation of the Breit–Wigner expression for one resonance are lost here, e.g., in that the partial widths are not simply related to SU(3) couplings. Generalizing a previous result for a single channel, a multichannel formalism for two overlapping resonances is presented in which the masses and widths are the usual one-state nonoverlapping or "isolated" quantities. This formalism should be attractive for phenomenological analysis of the A_2. (auth)

13684 S-WAVE $\pi\pi$ SCATTERING IN THE EFFECTIVE-POTENTIAL APPROXIMATION. Everett, Allen E. (Tufts Univ., Medford, Mass.). Phys. Rev., D; 4: No. 9, 2797-2800 (1 Nov 1971).

The I = 0 and I = 2 $\pi\pi$ S-wave phase shifts are calculated, using the effective-potential model with ρ and f^0 exchange which

has yielded an earlier successful $\rho-f^0$ double bootstrap. Scattering lengths and a broad S-wave resonance in fair qualitative agreement with current experimental indications are obtained. However, the I = 0 phase shift becomes negative between about 350 and 700 MeV, in disagreement with the dispersion-theory analysis of Morgan and Shaw and with current-algebra predictions on the energy derivative of the amplitude. (auth)

13685 RESONANCE SPLITTING. Aubrecht II, Gordon J.; Scott, David M.; Tanaka, K.; Torgerson, R. (Ohio State Univ., Columbus). Contract AT(11-1)-1545. Ann. Phys. (N. Y.); 68: No. 2, 499-508(Dec 1971).

The dipole-like structure of certain resonances (notably the A_2 meson) is obtained in a simple way. A pole is inserted in the generalized phase space factor of the single channel Veneziano–Lovelace K-matrix formalism near an ordinary resonance. The occurrence of the pole near the resonance appears accidental within the single-channel framework. The sum of the widths of the double resonance peaks approximates the width of the single resonance which would have been obtained had the extra pole been absent. The present approach is related to several previous descriptions. (auth)

13686 VENEZIANO MODEL AND CURRENT ALGEBRA. Maurone, Philip Anthony. Boston; Northeastern Univ. (1971). 144p. University Microfilms Order No. 72-595.

Thesis.

The $\pi\pi-\pi\pi$, $\pi\pi-\pi A_1$ and $\pi A_1-\pi A_1$ processes are analyzed using the hard-pion constraints of chiral current algebra, conservation of vector current and the partial conservation of the axial vector current on the Veneziano model with two mesons off the mass-shell. Crossing symmetry constraints with one or two spin one mesons off the mass-shell are explored and a minimal set of equations incorporating the full content of the condition of partial conservation of axial current and of crossing symmetry are obtained. Solutions for all the amplitudes describing $\pi A_1-\pi A_1$ processes are obtained which are consistent with previous determination of the $\pi\pi-\pi\pi$ and $\pi\pi-\pi A_1$ processes. The hard meson analysis shows that if one wants to maintain Veneziano forms with one or two mesons off the mass-shell, some of the $\pi A_1-\pi A_1$ amplitudes must develop poles in the off-shell momenta q_2^2 or $q_4^2 = 0$ as has already been noted for the process $\pi\pi-\pi A_1$. Also as before the soft-pion vertex function equations can be recovered if one removes the leading part of the singularity at the soft-pion $q_2^\mu = 0$ or $q_4^\mu = 0$. Again in a manner similar to the one encountered for the process $\pi\pi-\pi A_1$, the resulting amplitudes are still singular for $q_2^2 = 0$ or $q_4^2 = 0$ except at the soft-pion point for a continuum of s, t and u. Some of the off-shell amplitudes have in addition fixed poles introduced due to the presence of the local current algebra. The helicity amplitudes are however free of this singularity. A continuation back to the mass shell is made and it is shown that all the amplitudes satisfy factorization and no parity doubling condition to leading order. (Diss. Abstr. Int., B)

13687 TOPICS IN DUALITY. Hogan, William Lawrence. Boston; Northeastern Univ. (1971). 87p. University Microfilms Order No. 72-592.

Thesis.

Four problems in strong interaction physics are given. The process $\bar{p}n \to \kappa\bar{\kappa}\pi$ at threshold is investigated using the Veneziano model. At threshold the initial state has the quantum numbers of a π or a ρ. Therefore, to describe the interaction the four-point $\pi\kappa \to \pi\kappa$ and $\rho\kappa \to \pi\kappa$ Veneziano amplitudes are crossed into the decay regions of the initial π and ρ, having extrapolated these masses to twice the mass of a nucleon. It is found that reasonable adjustment of the parameters in the model allows qualitative agreement between theory and the available experimental data. Finite energy sum rules (FESR) are derived for the process $\rho\rho \to \rho\sigma$. Substitution of specific values of t into the FESR yields a set of homogeneous equations involving masses and coupling constants. A nontrivial solution to these equations in terms of a relation between the coupling constants is obtained for the case of a direct channel β meson resonance and a ρ Regge exchange. Using the formalism of the previous problem the intermediate ρ Born contribution to the parity conserving helicity amplitudes (PCHA) is calculated for the process $\rho\rho \to \rho\sigma$. Then the z-asymptotic limit of the PCHA is taken, and the leading coefficients for factorization are investigated. It is found that factorization does not occur. The t-channel Regge amplitudes for the processes $\pi\eta \to \pi\eta$ and $\pi\eta \to \pi\rho$ are examined for local duality. In the case of $\pi\eta \to \pi\eta$ loops are found in the Argand plots for the J = 0, 1, and 2 partial waves. Two of these, J = 0 and 2, have resonance points in the vicinity of expected resonances, viz., δ and A_2. For $\pi\eta \to \pi\rho$ a loop is found in the J = 2 Argand plot with mass in the neighborhood of the expected A_2 resonance, and no loop is found for J = 1 where there are no known resonances. (Diss. Abstr. Int., B)

13688 EFFECTIVE LAGRANGIAN TECHNIQUES FOR MESON DECAYS. Costanzi, Frank Albert. Evanston, Ill.; Northwestern Univ. (1971). 89p. University Microfilms Order No. 71-30,769.

Thesis.

The method of effective lagrangians is explored, and specific applications to meson decays are made. The essential assumptions which form the basis of the effective lagrangian technique are discussed, and the consequences of these assumptions are examined. The work is begun by considering a lagrangian describing a world composed of ρ, π, and A_1 mesons, which was employed in a hard-pion calculation of the pion electromagnetic mass difference. Next this lagrangian is extended to include octets of pseudoscalar, vector, and axial-vector mesons, incorporated in the symmetry group SU(3). The PVV coupling which breaks SU(3) is discussed, and this lagrangian along with the broken SU(3) PVV coupling is applied to the $K\pi\pi$ mode of K^* decay. The SU(3) lagrangian is further generalized to the chiral group $SU(3) \otimes SU(3)$. The origins and effects of chiral invariant and chiral breaking terms are studied. It is observed that mixing of the η and X^0 pseudoscalar mesons plays a significant role in this lagrangian due to an enhanced contribution of the zeroth pseudoscalar field to η processes. The radiative decay rates of the η and X^0 mesons are then calculated, and the predictions of the SU(3) lagrangian are examined in the light of $\eta-X^0$ mixing in the chiral lagrangian. Lastly, the $\eta \to 3\pi$ problem is considered. It is found that in a pion pole model one can calculate a decay rate consistent with experiment for the $\eta \to 3\pi$ process, while maintaining consistency with other η processes. (Diss. Abstr. Int., B)

13689 APPLICATIONS OF THE VECTOR MESON DOMINANCE MODEL. Buchl, Robert Anthony. Temple, Ariz.; Arizona State Univ. (1971). 108p. University Microfilms Order No. 71-31,137.

Thesis.

A number of different problems in elementary particle physics associated with the vector meson dominance model are given. In particular, the vector meson dominance model is discussed from a historical viewpoint and a Lagrangian formalism is developed by which the vector mesons are treated as essentially stable particles. The current field identity that follows is shown to relate the current of a vector meson to the field of the vector meson. This is shown explicitly for the ρ^0 meson. A similar current field identity for the ω and ϕ mesons also holds and this current mixing model is consistent with vector meson dominance. This forms a basis for the topics discussed. (TSS) (Diss. Abstr. Int., B)

13690 NEW DUAL MODELS OF PIONS WITH NO TACHYON. Halpern, M. B. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 10, 3082-3(15 Nov 1971).

It is observed that the σ meson in the recently proposed dual model of Halpern and Thorn can (should) be reinterpreted as a pion in its own right. The resulting model has the π and ρ degenerate at zero mass, no fifth quantum numbers, and a generally reduced spectrum. A related second model has nonmultiplicative internal symmetry, a Pomeranchukon (and exotic states), a ρ at 1 GeV, and a zero-mass pion. Both models can be extended to include fermions. (auth)

13691 UNITARIZED VENEZIANO $\pi\pi$ SCATTERING AMPLITUDE CONSISTENT WITH POSITIVITY AND CROSSING-SYMMETRY CONSTRAINTS. Kang, Kyungsik (Brown Univ., Providence); Lacombe, M.; Vinh Mau, R. Phys. Rev., D; 4: No. 10, 3005-11(15 Nov 1971).

A complete K-matrix unitarization of the Veneziano amplitudes for pion–pion scattering is carried out. In contrast to previous works on this subject, the correct behavior of the partial waves at the left-hand cut threshold is taken into account. Crossing symmetry is enforced by determining the parameters from the Roskies sum rules, and the Martin inequalities are used to limit further the range of solutions. The resulting s and p waves are in good agreement with the most recent experimental information. (auth)

13692 POWER ENERGY INCREASE OF THE SCATTERING AMPLITUDE FOR VIRTUAL PARTICLES WITH HIGH SPINS. Frankfurt, L. L. (Ioffe Inst. of Physics and Tech., Leningrad), Yadern. Fiz.; 14: No. 4, 849-54(Oct 1971). (In Russian).

It is shown that the scattering amplitude of a virtual meson with spin J increases with energy no slower than $s^{[J]-2}$ and that the helicity amplitudes of the vector boson have a finite value at zero mass if (and only if) the vector current is conserved. The proof is based on analytical properties and on positiveness of the forward scattering amplitude. (auth)

13693 ELASTIC SCATTERING AND CHARGE EXCHANGE REACTIONS AT HIGH ENERGY IN THE THEORY OF COMPLEX ANGULAR MOMENTA. Boreskov, K. G.; Lapidus, A. M.; Sukhorukov, S. T.; Ter-Martirosyan, K. A. (Inst. of Theoretical

and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 4, 814-30(Oct 1971). (In Russian).

Available experimental data on the $\pi^{\pm}N$, $K^{\pm}N$, NN, and $\bar{N}N$ elastic scattering and charge exchange reactions at high energies are analyzed in framework of the theory of complex angular momenta with account of the moving cuts. The contribution from the cuts is parametrized in the exponential approximation effectively taking into account the production of particle showers in the intermediate states. Reasonable agreement with the experiment is obtained for the energies more than 10 GeV and at small momentum transfers. (auth)

13694 LOW-ENERGY ASPECTS OF A DUAL RELATIVISTIC QUARK MODEL. Venturi, G. (Univ., Bologna). Nuovo Cim.; 6A: No. 4, 499-515(21 Dec 1971).

A dual relativistic quark model is constructed for $\pi\pi$ and πN scattering amplitudes. The model has satisfactory high-energy behavior and mass spectrum, no parity doubling on leading trajectories, and at a pole the leading-trajectory contribution factorizes into a product of collinear $U_6 \otimes O_2$ covariant vertices. The model is found to give satisfactory predictions for s-wave scattering lengths. It is also compared with the current algebra and partially conserved axial vector current predictions and is found to be compatible with them. The implications of the model for understanding the latter are also discussed. (auth)

13695 MODEL FOR $p\bar{p}$ ANNIHILATION WHICH VIOLATES DUALITY. Caprasse, H.; Vandermeulen, J. (Univ., Liege). Nuovo Cim.; 6A: No. 4, 516-26(21 Dec 1971).

A model for $p\bar{p}$ annihilation into pions is worked out. It is based on two assumptions: quasi-two-body final states dominate the annihilations; each two-body amplitude is written as the product of two factors, one of which incorporates duality and the other takes into account thresholds effects. The relative magnitude and the energy dependence of the multipion cross sections are computed and the comparison with the data shows a reasonable agreement. (auth)

13696 FINITE-ENERGY SUM RULES ON HYPERBOLAS. II. Sandusky, J. C. (Univ. of Maryland, College Park). Nuovo Cim.; 6A: No. 4, 627-38(21 Dec 1971).

The finite-energy sum rules derived in preceding work are converted into a set of integral constraints on the reaction $\bar{N}N \to \pi\pi$. These sum rules provide information about the first eight partial waves for this reaction. Zeros above threshold are found for almost all partial waves, as well as strong evidence for background or daughters in the lower ones ($J \leq 3$). For $J = 4$ and 5, daughters are less evident. Application to Regge-residue parameters for P′ and ρ suggest that these residues "turn over" at large, positive t but do not charge sign. Values for the P′ residues indicate that the $A^{(+)}$ amplitude does not satisfy an unsubtracted dispersion relation. (auth)

13697 DUAL $\bar{K}N\bar{\Lambda}\pi\pi$ AMPLITUDE WITH SPIN. Hirshfeld, A. C. (Univ., Heidelberg); Schmidt, M. G. Nuovo Cim.; 6A: No. 4, 639-54(21 Dec 1971).

One of the most remarkable applications of the Veneziano model to experiment is the Petersson–Törnqvist treatment of $K^-p \to \Lambda\pi\pi$. This success is achieved despite the neglect of the baryon spins and involves the use of forbidden duality diagrams. A covariant spin and isospin decomposition of the $\bar{K}N\bar{\Lambda}\pi\pi$ amplitude is performed in terms of kinematic-singularity-free invariants, which satisfy crossing symmetry in a simple way. A dual representation of these amplitudes is given which satisfies factorization constraints for the lowest poles and has well-behaved Regge limits in all channels. The formula contains the simplest terms necessary for a simultaneous parametrization of all five-point processes in the $(\bar{K}N\bar{\Lambda}\pi\pi)$ complex, all four-point functions which occur at the meson and baryon poles, and the three-body couplings. (auth)

13698 UNITARIZED PION–PION VENEZIANO PARTIAL-WAVE AMPLITUDES. Kuehnelt, H. (Univ., Vienna); Widder, F. Nuovo Cim.; 7A: No. 1, 47-59(1 Jan 1972).

A unitarization method is investigated which is based on dispersion relations for the inverse amplitude; the zeros of the partial-wave amplitudes are taken from the Veneziano model and the discontinuity across the right-hand cut is given by elastic unitarity, whereas crossing symmetry yields the left-hand cut discontinuity (for large negative s-values the latter is assumed to be constant). Two free subtraction constants are fixed by minimizing the violation of crossing symmetry—expressed in terms of a number of exact conditions on the partial-wave amplitudes. It was not possible to satisfy all of the crossing constraints simultaneously, but a unique solution of the dispersion relations (with a very broad $I = 0$ S-wave resonance) was obtained which is unitary and approximately crossing symmetric. (auth)

13699 η AND η' PARTICLES IN THE PSEUDOSCALAR NONET. De Franceschi, G. (CNEN, Frascati, Italy); Reale, A.; Salvini, G. Annu. Rev. Nucl. Sci.; 21: 1-54(1971).

A review is given of the present state of knowledge on the pseudoscalar mesons η and η'. The objectives are to establish the extent of knowledge on the production rate, specific properties, and decay modes of these particles and to discuss the foundation of the pseudoscalar nonet and its position in the unitary symmetries. The eta production at low energy and decay modes, test of C invariance in η decays, the η' particle, the 0^- nonet, theory of η decay, high-energy production of the eta with the Primakoff effect, and open problems concerning the η and η' particles are treated. (J.F.P.)

13700 EXCITATIONS IN A DENSE BARYON–ANTIBARYON SYSTEM. Chervenak, W. J. (Bellarmine-Ursuline Coll., Louisville, Ky.); Burt, P. B. Czech. J. Phys.; 21: No. 11, 1136-40(1971).

The self-consistent field approximation was applied to a distribution of spin-$\frac{1}{2}$ baryons and antibaryons interacting through a classical neutral pseudoscalar meson field. Excitations in the distribution due to density fluctuations are described by an equation relating the meson field frequency ω to the nucleon coupling strength. The ω was evaluated at zero temperature and zero momentum transfer and it is found that the ratio ω/M_n is very close to the ratio m_π/M_n, where M_n is the nucleon mass and m_π the meson mass. For this limiting case, $T = q = 0$, the excitation frequency depends only upon terms characteristic of the particle-antiparticle interaction. Therefore the π^0 meson is interpreted as the lowest excitation of a bound nucleon-antinucleon pair. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 13539 and 13767.

13701 (TID-25878) THE UNIQUENESS OF INTERACTIONS INVOLVING HIGHER SPIN PARTICLES. Etemadi, Babak (Florida State Univ., Tallahassee. Coll. of Arts and Sciences). Dec 1971. Contract AT(40-1)-3509. 92p. Dep. NTIS.

Thesis.

The free-field Lagrangian, as well as the propagators for particles of spin greater than one, contain one or more arbitrary parameters. However, the S-matrix elements for the interaction of a high spin field with other fields ought to be always independent of these parameters, provided the interaction Lagrangian is properly chosen. To select the proper interaction Lagrangian, the invariance of the interaction Lagrangian under a certain set of point transformations should be utilized, and at every step the consistency with the principles of second quantization should be confirmed. This consistency can be realized either by quantizing the interacting fields on space-like surfaces or by using generalized Matthew's rule. This approach is applied to a system of a spin-$\frac{3}{2}$ field coupled to a nucleon and a pion field. The coupling of a spin-2 field to two pion fields is considered also. The uniqueness of S-matrix elements for these cases is shown explicitly. Using this model for the evaluation of the $\Delta(1238)$ and $f_0(1260)$ contributions and the usual chiral invariant Lagrangian for the nucleon pole and rho pole contributions, the πN and $\pi\pi$ scattering lengths were computed and compared with the experimental data. (auth)

13702 ANALYSIS OF REGGEON-PARTICLE SPIN COUPLINGS IN FEYNMAN-DIAGRAM MODELS OF REGGEIZATION. Morrow, Richard A. (Univ. of Maine, Orono). Phys. Rev., D; 4: No. 9, 2852-7(1 Nov 1971).

An attempt is made to fit certain data for the reactions $K^{\pm}p \to K^*(890)\pi^{\pm}p$ and $\pi^{\pm}p \to \rho^{\pm}p$ using simple Regge models incorporating the Reggeon-particle spin couplings of Blankenbecler and Sugar. The aim is to see if a universal form of such spin couplings exists. It is shown that this is not the case if simple, unadorned Regge models are used, but that if absorption is appealed to virtually any type of spin coupling will yield successful fits to existing data. (auth)

13703 POLARIZATION AND SUM RULES IN THE COMPLEX-REGGE-POLE MODEL OF πN CHARGE-EXCHANGE SCATTERING. Barik, N.; Desai, Bipin R.; Kaus, Peter; Park, Robert T. (Univ. of California, Riverside). Phys. Rev., D; 4: No. 9, 2923-6(1 Nov 1971).

Recent polarization data and finite-energy sum rules are used to show that the phase of the residues (associated with trajectory $\alpha_+ = \alpha_R + i\alpha_I$, $\alpha_I > 0$) of $A'^{(-)}$ and $B^{(-)}$ must be negative with the crossover and the dip zeros related to the value $-\pi/2$. The polarization vanishes at $t \simeq -0.65$ $(BeV/c)^2$ when the two phases become equal. The residue for $B^{(-)}$ has the same real part ($\sim\alpha_R$) but opposite phase to α_+. (auth)

13704 ADLER-WEISBERGER THEOREM REEXAMINED. Brown, Lowell S.; Pardee, W. J.; Peccei, R. D. (Univ. of Washington, Seattle). Phys. Rev., D; 4: No. 9, 2801-10(1 Nov 1971).

The nature of the current-algebra constraints on the on-mass-shell amplitudes of pion-nucleon scattering at $s = m_N^2$, $t = 2m_\pi^2$ is considered. It is proved that, at this point, an even amplitude is determined up to corrections of order m_π^4 and that the corrections to an odd amplitude are of order m_π^2. Thus, the σ term in the even amplitude, which is of order m_π^2, can be determined, confirming the recent work of Cheng and Dashen. However, such a determination cannot be made with a mixture of even and odd amplitudes as von Hippel and Kim have attempted to do. The actual magnitude of the corrections is estimated from what should be the dominant physical mechanisms: the large nucleon size and the proximity of the strong 3-3 resonance state. These corrections are insignificant for the even amplitude. For the odd amplitude, they are separately large, about 10%, but they cancel for the most part and give a much smaller contribution. Corrections due to other resonances are insignificant compared to the 3-3 contribution. The Adler-Weisberger theorem, with the on-shell method, relates the pion-nucleon coupling constant f to the pion decay constant and an integral over the absorptive part of the physical π-N scattering amplitude; it does not involve the axial-vector coupling constant g_A. It is found that this relation gives $f^2 = 0.077$, which is to be compared to direct evaluations which range from $f^2 = 0.082$ to $f^2 = 0.076$. It is concluded that these current-algebra theorems may well be satisfied to a considerable degree of accuracy. More precise low-energy pion-nucleon scattering data are needed, however, for a definitive test. (auth)

13705 ANALYSIS OF π^+p ELASTIC SCATTERING FROM 2.74 TO 4.0 GeV/c AT ALL ANGLES. Chu, Shu-yuan; Hendry, Archibald W. (Indiana Univ., Bloomington). Phys. Rev., D; 4: No. 9, 2743-50(1 Nov 1971).

π^+p elastic scattering is analyzed in terms of s-channel helicity amplitudes. It is demonstrated that the data are consistent at all angles with the picture of scattering from an interaction region of radius 0.8 F, with special edge effects accounting for backward scattering. (auth)

13706 RESOLUTION OF THE πN HELICITY-CONSERVATION QUESTION FROM POLARIZATION DATA ALONE. Barger, V.; Halzen, F. (Univ. of Wisconsin, Madison). Contract AT (11-1)-881. Phys. Rev. Lett.; 28: No. 3, 194-7(17 Jan 1972).

A definitive test that distinguishes s- from t-channel helicity conservation in πN scattering is carried out. A quantitative measure of the $I_t = 0$ helicity-flip amplitude is proposed and evaluated using only polarization data. The violation of s-channel helicity conservation is found to die away with a $(P_{lab})^{-2}$ energy dependence in the range 2 to 11 GeV. (auth)

13707 PHASE OF THE ϕ-NUCLEON FORWARD SCATTERING AMPLITUDE. Krammer, Margarete (Deutsches Elektronen-Synchrotron, Hamburg). Acta Phys. Austr.; 32: No. 3-4, 395-400(Mar 1970).

The quark model is used to calculate the real and imaginary part of the elastic ϕ-nucleon forward scattering amplitude. The imaginary part of the forward amplitude is recalculated from the quark model relation, and the real part is obtained from the same relation by using the actual experimental data. The ratio of the real and imaginary parts for the studied elastic scattering in the range $7 < p_{lab} < 15$ GeV/c is found to be $\alpha = -0.3 \pm 0.45$. (J.F.P.)

13708 REGGE POLE ANALYSIS OF π^-p BACKWARD SCATTERING. Schneider, Frank. Lincoln, Neb.; Univ. of Nebraska (1971). 135p. University Microfilms Order No. 72-177.

Thesis.

A Regge Pole Analysis of the Anderson data on π^-p elastic scattering, ρ production, A1 production, and A2 production was obtained in the helicity frame. The parameterization incorporates the present beliefs about Regge phenomenology: MacDowell symmetry, kinematic singularities, sense-nonsense zeros, constraints, cancellation of kinematic singularities in momentum transfer, and the absence of the parity partner of the (3,3) resonance. Regge cuts are not included. A parameterization of the residues satisfying all these requirements can be obtained with at most two free parameters. A satisfactory fit of these four processes was obtained with the same linear Δ trajectory in each. The parameters determined by the fitting procedure are used to calculate a variety of other results. (Diss. Abstr. Int., B)

13709 FIXED-u FINITE-ENERGY SUM RULE CALCULATIONS FOR πN SCATTERING USING REALISTIC SPECTRAL FUNCTIONS. Sowash, Laurence J. East Lansing, Mich.; Michigan State Univ. (1971). 113p. University Microfilms Order No. 71-31,310.

Thesis.

Realistic spectral functions were used to calculate fixed-u finite energy sum rules (FESR) for πN scattering. The FESR equate positive integral moments of the Regge and low-energy scattering amplitudes. The fixed-u FESR isolate baryon Regge amplitudes which dominate high-energy backward scattering. The generation of realistic spectral functions involves detailed consideration of t-channel threshold properties. Regge convergence properties implicit in the sum rules are used to choose between available sets of direct channel phase shifts. The FESR are used to fit coupling constants for I = 0, 1 mesons. The calculations are extended to higher moments than possible in previous calculations. (Diss. Abstr. Int., B)

13710 DETERMINATION OF THE ISOSCALAR S-WAVE PION-PION PHASE SHIFT WITH ABSORPTION MODIFIED OPE. Kim, Hyungski. Irvine, Calif.; Univ. of California (1971). 75p. University Microfilms Order No. 72-2240.

Thesis.

Absorption modified one pion exchange model was applied to the reaction $\pi^-p \to \pi^-\pi^+n$ at 4 GeV/c in order to obtain the isoscalar S wave pion pion phase shift. The dipion mass region from 300 MeV to 1 GeV was studied with elastic partial waves S, P and D where P and D waves are parametrized by the Breit-Wigner formulas with energy dependent widths assuming the resonance ρ and f_0 dominance respectively while S waves are parametrized by relativistic effective range formulae assuming that the isotensor S wave is also known. The result of maximum likelihood fit to dipion mass spectrum, $\cos\Theta_{\pi\pi}$ and the Treiman-Yang angle distributions averaged over $-t$ from $-t_{min}$ to $3m_\pi^2$ favored an isoscalar S wave resonance with very broad width at somewhere around 800 MeV. (Diss. Abstr. Int., B)

13711 DUAL QUARK MODEL WITH SPIN. Ellis, Stephen Dean. Pasadena, Calif.; California Inst. of Tech. (1971). 133p. University Microfilms Order No. 72-472.

Thesis.

A dual quark model is developed from the usual Veneziano model by explicitly including the Dirac spin of the quarks. Resonances appear without the parity doubling and new ghosts present in previous models with spin. This is accomplished by eliminating the contributions of the negative parity components (MacDowell twins) of the spin $\frac{1}{2}$ quarks through the introduction of fixed J-plane cuts. The resonances belong to an SU_6 symmetric spectrum identical, on the leading trajectory, with that of the usual static symmetrical quark model. All resonances couple via $SU_{6_W} \times O_{l_z}$ symmetric vertices and the model factorizes with essentially the same degeneracy as the usual Veneziano model. As a consequence of requiring these two features the model acquires further new structure which is studied in detail in terms of the asymptotic behavior of the model. This new structure leads to unavoidable "background" contributions to the imaginary parts of the amplitudes not present in previous dual models. This situation is examined and interpreted in the language of finite energy sum rules. In order to test the basic features of the model explicit calculations are made for the case of pion-nucleon scattering in the Regge limit. To make the numerical work easier a somewhat simplified version of the model is used. Although the results of the calculations are suggestive of reasonable J-plane structure for the various amplitudes, i.e., the location of Regge pole-fixed cut interference is reasonable from the standpoint of the data, the overall kinematic behavior of the amplitudes is definitely not compatible with what is measured. However, it is noted that this kinematic behavior depends strongly on those details of the model which were simplified in the present study. If such models are to be unambiguously and successfully tested against data, future studies must treat these details more completely and realistically, including both unitarity and symmetry breaking effects. (Diss. Abstr. Int., B)

13712 π-N SCATTERING IN THE OPERATOR DROPLET MODEL. Lo, S. Y.; Reid, A. W. (Glasgow Univ.). Nucl. Phys.; B36: No. 2, 493-511(1972).

π-N scattering is treated within the framework of the operator droplet model. Spin dependent effects were incorporated and the differential cross section, polarization and spin rotation parameters, R and A, were calculated at infinite energy. Considerable structures in R and A were found in contrast with the prediction of the present favorite idea of S-channel helicity conservation for high-energy scattering. The original parametrization of the fit of Byers and Yang for $\pi^-p \to \pi^0n$ is used to calculate energy dependent amplitudes in elastic πN scattering. Without any new parameters, a good fit was obtained for total cross sections, polarization and a consistent fit for the R- and A-parameters. Further possible developments are indicated. (auth)

13713 DETERMINATION OF πN SIGMA TERM FROM PION NUCLEUS SCATTERING. Hakim, Shafik, J. (Univ. of Michigan, Ann Arbor). Nucl. Phys.; B36: No. 2, 436-44(1972).

Use is made of the current algebra sum rules developed by Fubini and Furlan for pion-nucleon scattering to evaluate π^--nucleus scattering lengths. Assuming that the pion-nucleus sigma term Σ can be written as a coherent sum of pion-nucleon sigma terms S and using experimental data S is determined for each reaction tested averaging 22 ± 1 MeV. With $S = 22 \pm 1$, π-nucleus scattering lengths are calculated and the results indicate a good agreement with experimental data. (auth)

13714 STRUCTURE EFFECTS IN PION–NUCLEON BREMSSTRAHLUNG. Fischer, W. E.; Minkowski, P. (SIN, Zurich). Nucl. Phys.; B36: No. 2, 519-40(1972).

Using a soft photon theorem photon angular distribution and cross sections of π^+p bremsstrahlung are calculated in terms of π^+p phase shifts. Off-shell and structure effects are discussed and calculated. The investigation of these structure effects gives hints of future experiments in that field in order to determine the magnetic moment of the N*-resonance. (auth)

13715 DUAL-RESONANCE MODEL FOR THE $K^-K^+p\bar{n}\pi^-$ SYSTEM WITH APPLICATION TO THE REACTION $K^-p \to K^-\pi^+n$ AT INCIDENT MOMENTA FROM 1.33 TO 11.2 GeV/c. Lyberg, M. D. (Univ. of Lund, Sweden); Gislen, L. Nuovo Cim.; 6A: No. 4, 527-42(21 Dec 1971).

A dual-resonance model for the $K^+K^-p\bar{n}\pi$ system is constructed with the intention of having as few parameters as possible. After having fixed these parameters by fitting the Jackson angle distribution in the reaction $K^-p \to K^{*0}n$ at 4.1 GeV/c incident momentum, the prediction of the model is compared to experiment for the reaction $K^-p \to K^-\pi^+n$ and the subreactions $K^-p \to K^{*0}n$ and $K^-p \to K^{**0}n$ at incident momenta varying from 1.33 GeV/c to 11.2 GeV/c. Data on mass distributions, differential cross sections, Jackson and Treiman–Yang angle distributions and total cross sections are considered. The overall agreement is fairly good. (auth)

13716 SOME CRITICISMS OF PHENOMENOLOGICAL MODELS. Benayoun, M.; Leruste, P. (College de France, Paris). Nuovo Cim.; 6A: No. 4, 441-54(21 Dec 1971).

It is proven that some phenomenological models often used to describe experimental data in the framework of many-channel scattering can be obtained as approximations of various kinds of the D/D formalism previously developed. Limitation is made to the analysis of the rational approximation to which varying-width Breit–Wigner formulas as well as the effective-range theory of Ross and Shaw are connected. Using the D/D formalism one can easily prove relative irreducibility properties of these models. One can, therefrom, deduce an explanation concerning the diverging descriptions — obtained through these models — of the same experimental data. This is, in particular, shown by means of an analysis of the S_{11}-wave of πN scattering; one is also led to emphasize some arguments to explain the deviation of the phenomenological $Y_0^*(1405)$ coupling constant from the unrefined SU_3 predictions. One is thus led to ask a question about the very nature of a resonance: is it a single pole of the T-matrix or of the K-matrix? (auth)

13717 HIGH-MULTIPLICITY PROCESSES. Suranyi, P. (Johns Hopkins Univ., Baltimore). Nuovo Cim.; 6A: No. 4, 473-98(21 Dec 1971).

Asymptotic expansions in the variable $v = n/\log E$ (where n is the secondary multiplicity and E is the primary energy) are given for the phase space and for an amplitude satisfying some general conditions. The leading term in the momentum distribution is found to be independent of further details of the dynamics except for one constant, the n and E dependence of which is determined only by some dynamic properties of the system. The predicted distribution agrees with experimental data on 25 GeV π^--p interactions. A study of these data allows one to predict $d\sigma/d^3p$ for arbitrary primary-energy and high-multiplicity interactions. A thermodynamic picture equivalent to the results is given. (auth)

13718 COMPLEX CONJUGATED REGGE TRAJECTORIES AND SUM RULES. Zotov, N. P.; Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 14: No. 4, 806-13 (Oct 1971). (In Russian).

Experimental data on the $\pi^-p \to \pi^0n$ reaction are analyzed in framework of the model of complex conjugated Regge trajectories. The parameters obtained by means of the sum rules from the low-energy data describe reasonably the differential cross sections and polarization at high energies. (auth)

13719 FINITE-ENERGY SUM RULES ON HYPERBOLAS. I. Greenberg, P. W.; Sandusky, J. C. (Univ. of Maryland, College Park). Nuovo Cim.; 6A: No. 4, 617-26(21 Dec 1971).

Dispersion relations and finite-energy sum rules (FESR's) on hyperbolas in the real Mandelstam plane which are asymptotic to lines of fixed s and u together with an ellipse on which s and u are complex are derived. These FESR's on hyperbolas are applied to backward and near-backward πN scattering and are used to extract information about the first eight partial-wave amplitudes for the reaction $N\bar{N} \to \pi\pi$. (auth)

13720 CONSTRUCTION OF SCATTERING AMPLITUDES FROM EXPERIMENTAL DATA AND ANALYTICITY. Alvarez-Estrada, R. F. (Faculte des Sciences, Orsay, France). Ann. Phys. (N. Y.); 68: No. 1, 196-243(Nov 1971).

The modulus (phase) representation of analytic functions, which expresses them in terms of their complex zeroes and a dispersion integral over their modulus (phase) on the real axis, is studied in general. Under certain conditions it is shown that the scattering amplitude in nonrelativistic potential scattering has a finite number of zeroes in the complex energy plane (s) at fixed momentum transfer (t), and the fixed-t modulus representation and the t = 0 phase representation in the s-plane are given for it. The modulus representation for the relativistic $\pi^\pm p \to \pi^\pm p$ and $\bar{p}p \to \pi^+\pi^-$ transversity amplitudes in the laboratory frame are presented, after discussing their complex zeroes. The t = 0 phase representation for $\pi^-p \to \pi^-p$ is also given. All of them give the corresponding scattering amplitude if differential cross sections and polarizations are available and if the complex zeroes and certain unphysical region contributions are known. Several methods are proposed to find out the latter two: superconvergent modulus representations and superconvergent sum rules coming from them, combination of t = 0 phase and modulus representations, sum rules coming from analyticity and non-oscillation at infinity, approximate modulus representations for high-energy scattering and optimalized polynomials to perform analytic extrapolations. The generalization to N–N scattering is treated briefly, the main consequence being to stress the interest of measuring the polarization parameters C_{nn}, D_{nn} and K_{nn}. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 13748 and 13947.

13721 (JINR–E4-6095) ESTIMATE OF UPPER AND LOWER BOUNDS TO CHARACTERISTICS OF TWO- AND THREE-BODY SYSTEMS. Belyaev, V. B.; Zubarev, A. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 10p. Dep. NTIS (U. S. Sales Only).

It is suggested to use special separable potentials constructed on the basis of a given local potential for obtaining the lower and upper bounds of the binding energy for three particles and the binding energy and scattering lengths for two particles. The suggested method of separation of local potentials is applied to potentials of the Gauss type and of the exponential one with subsequent solving of the Faddeev equations with approximate potentials. The difference between the upper and lower bounds of the binding energy of tritium was thus found to be a few fractions of a percent of the energy of tritium. (auth)

13722 (JINR–P4-6156) ON A METHOD OF SOLVING THE PROBLEM OF nd SCATTERING AT POSITIVE ENERGIES. Belyaev, V. B.; Efimov, V. N.; Shul'ts, Kh. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The problem of the quartet nd-scattering with point interaction at the total positive energy is considered. The moving singularities of the kernels are eliminated on the basis of the Faddeev theorem about the smoothness of iterated kernels. The solution is obtained in the analytical form by means of the iterated kernel expansion into the correspondingly chosen system of orthogonal functions. (auth)

13723 (LBL–500, pp 157-65) HIGH ENERGY PHYSICS WITH POLARIZED PROTON BEAMS. Berger, Edmond L. (Argonne National Lab., Ill.); Fox, Geoffrey C. (California Inst. of Tech., Pasadena). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Various areas of high-energy physics in which significant new information can be obtained from experiments with polarized proton beams are explored. A broad range of interesting experiments may be carried out for both elastic and inelastic processes. (auth)

13724 (NP–19151) SHORT-RANGE CONSTRAINTS FOR N–N MOTION. Lilja, I. A. (Jyvaskyla Univ. (Finland). Dept. of Physics). Oct 1971. 7p. Dep. NTIS (U. S. Sales Only).

The velocity-dependent N–N forces are not dissipative if nonholonomic constraints are introduced into the problem of short-range nucleon–nucleon interactions. (auth) (Finland)

13725 DEUTERON SPIN ALIGNMENT AS A TEST FOR DOUBLE-SCATTERING CONTRIBUTIONS IN THE GLAUBER THEORY. Wolfenstein, L. (Univ. of Michigan, Ann Arbor. Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 4: No. 9, 2917-18(1 Nov 1971).

It is shown that in the single-scattering approximation to the Glauber theory of high-energy deuteron scattering there exists a relation between the two nonvanishing parameters describing the deuteron spin alignment. The failure of this relation can be used as a test for the expected importance of double-scattering terms at larger angles in elastic π-d or p-d scattering. (auth)

13726 LONG-RANGE CORRELATIONS AND THE DYNAMICS OF MULTIPARTICLE PRODUCTION. Friedman, Jerome H.; Risk, Clifford; Smith, Dennis B. (Univ. of California, Berkeley). Phys. Rev. Lett.; 28: No. 3, 191-4(17 Jan 1972).

It is shown that the negative transverse-angle correlation between leading particles in multiparticle production, required by momentum and energy conservation, is substantially reduced if the secondaries are correlated in longitudinal momentum with the leading particles. The multiperipheral model, which has the pions produced with ordered longitudinal momenta, and a pionization model, which has each pion produced randomly in longitudinal phase space, are compared with experimental results for $pp \rightarrow pp\pi^+\pi^+\pi^-\pi^-$ at 23 GeV/c. The data strongly favor random pion production. (auth)

13727 INTERPOLATION OF THE ENERGY DEPENDENCE OF PARTIAL-WAVE AMPLITUDES. Cutkosky, R. E.; Shih, C. C. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 4: No. 9, 2750-60(1 Nov 1971).

Two methods are described for interpolating the energy dependence of phase shifts. Both methods are based on normed analytic approximation theory. The first method interpolates the D function of the N/D method; the second interpolates the logarithm of this function. As an illustration, the methods are applied to the $^1S_0$ and $^1P_1$ n-p phase shifts below 400 MeV. (auth)

13728 DYNAMICS OF REACTIONS OF PION–PION COHERENT GENERATION AT HIGH ENERGIES. Azimov, S. A.; Beter, E. V.; Grishin, V. G.; (and others) (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 14: No. 4, 831-6(Oct 1971). (In Russian).

It is shown that the main experimental characteristics of reactions of the pion-pion diffraction coherent generation on compound nuclei (effective mass distributions of produced pions, their energy dependence, the dependence of cross sections of these reactions on the energy and on the nucleon number in nucleus) in the accelerator energy region can be reasonably described by the Deck model. (auth)

13729 HIGH-ENERGY PROTON–PROTON COLLISION BY A SOLVABLE MODEL. Calucci, G.; Jengo, R.; Rebbi, C. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo Cim.; 6A: No. 4, 601-16(21 Dec 1971).

The reactions induced by high-energy proton-proton collisions are analyzed in terms of a theoretical model, which incorporates exact s-channel unitarity. A unified description of the salient aspects of high-energy proton-proton interactions is obtained. Among those aspects one chooses for more detailed analysis: the total cross section, the multiplicity, the distribution of the number of the emitted particles, the elastic cross sections and, with particular attention, the inclusive reactions $p + p \rightarrow \pi +$ anything and $p + p \rightarrow p +$ anything. A comparison with the experimental data is presented and the general agreement turns out to be satisfactory. (auth)

13730 LIFETIME, BRANCHING RATIO AND BINDING ENERGY OF THE LAMBDA–HYPERTRITON. Williams, John Wesley. Las Cruces, N. Mex.; New Mexico State Univ. (1971). 65p. University Microfilms Order No. 71-24,987.

Thesis.

Two-body and total decay rates for ${}^3_\Lambda H$ are evaluated using the recent spatial wave functions for ^3He and ${}^3_\Lambda H$ obtained by Herndon and Tang from a variational calculation for these systems in which the lambda–nucleon and nucleon–nucleon s-wave interactions are represented by central, spin-dependent, and charge-independent potentials with hard-core radii from 0.3 fm to 0.6 fm. These decay rates are used to determine values for the decay lifetime and branching ratio $R_3 = \Gamma({}^3_\Lambda H \rightarrow \pi^- + {}^3He)/\Gamma(\text{all } \pi^- \text{ modes})$ of ${}^3_\Lambda H$. Experimental values for the branching ratio are then combined with expressions obtained from the decay rates to obtain a value for the binding energy of the Λ particle to the deuteron core. Results of the calculations using wave functions corresponding to potentials with a hard-core are compared to the results obtained from simple exponential wave functions for ^3He and ${}^3_\Lambda H$ without hard-core distortions. The results indicate that the calculated decay rates for ${}^3_\Lambda H$ are not sensitive to the presence of a hard-core in the lambda–nucleon and nucleon–nucleon interaction potentials. While both spin ½ and spin 3/2 states are possible for ${}^3_\Lambda H$, calculated values of the branching ratio R_3 indicate that the spin of the hypertriton is ½. Under the assumption that J = ½ for ${}^3_\Lambda H$, it is found that the decay lifetime of ${}^3_\Lambda H$ is not appreciably different from the decay lifetime for a free Λ particle, and that the binding energy of the particle to the deuteron core is between 0.1 and 0.3 MeV. (Diss. Abstr. Int., B)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 13793 and 14191.

13731 STATISTICAL WEIGHTS OF MANY-PARTICLE SYSTEMS IN UNITARY-SPIN SPACE. Nicorovici, N. (Inst. for Atomic Physics, Bucharest). Nucl. Phys.; B36: No. 2, 485-92(1972).

The statistical weight for a n-particle state obtained from a high-energy collision is carried out using the SU(3)-symmetry model, the method developed by Cerulus for similar quantities in the SU(2) approach and the SU(3) parametrization introduced by Holland. (auth)

13732 BASIS FOR THE IRREDUCIBLE REPRESENTATIONS OF U_n IN THE CHAIN $U_n \supset R_n$. Prasad, L.S.R.K. (Andhra Univ., Waltair, India). Nucl. Phys.; B36: No. 2, 605-14(1972).

A polynomial basis for the irreducible representations of U_n in the chain $U_n \supset R_n$ pertaining to the harmonic oscillator potential is obtained explicitly. (auth)

13733 SYMMETRY BREAKING IN A FIELD THEORY OF CURRENTS. I. de Gouville, Ch. Le Monnier; Papastamatiou, N.; Umezawa, H. (Univ. of Wisconsin, Milwaukee). Phys. Rev., D; 4: No. 10, 2966-76(15 Nov 1971).

A model of symmetry breaking is presented for a field theory of currents through the divergences of vector and axial-vector currents. The assumption of partial conservation of vector current (PCVC) and partial conservation of axial-vector current (PCAC) for the nonvanishing divergences allows an explicit connection to be made between the form of the symmetry-breaking part of the energy-momentum tensor and the nonlinear realization of the internal symmetry. It is shown that for SU(2) and SU(3) the vanishing of exotic commutators fixes uniquely the symmetry breaking as well as the nonlinear realization for the divergences of the currents. (auth)

13734 CONFORMAL PICTURES IN QUANTUM MECHANICS. Perlman, H. S. (Monash Univ., Clayton, Australia). Phys. Rev., D; 4: No. 10, 3220-1(15 Nov 1971).

A new class of pictures is defined via restrictions on the effects of dilatations. The utility of the concept is illustrated by the construction of a dilatation picture in which operators are scale-invariant. (auth)

13735 COMMENT ON THE SPONTANEOUS BREAKDOWN OF SCALE INVARIANCE. Callan, Curtis G. Jr. (Inst. for Advanced Study, Princeton, N. J.); Carruthers, P. Phys. Rev., D; 4: No. 10, 3214-16(15 Nov 1971).

In a recent paper, Bose and McGlinn concluded that there cannot be massive particles in the limit of spontaneously broken scale invariance. The assumptions on which their result is based are criticized. (auth)

13736 STRUCTURE OF THE WIGNER 9j COEFFICIENTS IN THE BARGMANN APPROACH. Wu, Alfred C. T. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.); 13: No. 1, 84-90(Jan 1972).

Bargmann's treatment of the Clebsch–Gordon (3j) and Racah (6j) coefficients is extended to the case of Wigner 9j coefficients. The generating function for the 9j coefficient is computed by the analytic method. The result is compared to the Schwinger's expression derived with the algebraic (boson operator) method. The full symmetry of the Wigner 9j coefficients is manifest and transparent in the Bargmann's formalism. A new explicit expression for the Wigner 9j coefficient is derived as a sixfold sum which may be regarded as the analog of the Racah's formula for the Racah coefficient. (auth)

13737 AN APPLICATION OF THE THEORY OF INVARIANTS. Devi, V. Syamala (Andhra Univ., Waltair, India). J. Math. Phys. (N. Y.); 13: No. 1, 28-33(Jan 1972).

The problem of finding highest-weight polynomials in certain chains of subgroups of the unitary group is shown to be related to finding semi-invariants of certain ground forms according to the theory of invariants developed by mathematicians long ago. (auth)

13738 REPRESENTATIONS OF THE CONFORMAL GROUP WHICH WHEN RESTRICTED TO ITS POINCARE OR WEYL SUBGROUPS REMAIN IRREDUCIBLE. Mickelsson, J.; Niederle, J. (Inst. of Physics, Prague). J. Math. Phys. (N. Y.); 13: No. 1, 23-7(Jan 1972).

Unitary irreducible representations of the conformal group which, when restricted to its Poincaré or Weyl (= Poincaré group extended by dilatations) subgroups, remain irreducible are found. In particular it is proved that the continuous-spin representations ($p_\mu \cdot p^\mu = 0$) of the Poincaré group cannot be extended to the conformal group and that, on the other hand, a known extension in the discrete spin case is unique (up to a unitary equivalence). Similar results hold for Weyl group for which, in addition, extensions also exist in the case $p_\mu \cdot p^\mu \neq 0$. Namely, each unitary irreducible representation of the Weyl group characterized by the sign of $p_\mu \cdot p^\mu$ ($\neq 0$) and by invariants of the corresponding little group can be extended to a one-parameter family of irreducible representations of the conformal group. Finally, it is shown that, besides the above mentioned extensions of unitary irreducible representations of the Weyl group, there are no others. (auth)

13739 COMPLETE SET OF COMMUTING OPERATORS FOR LADDER REPRESENTATIONS OF THE LIE ALGEBRA OF U(6,6). Nikolov, A. V. (Univ., Sofia). Teor. Mat. Fiz.; 9: No. 3, 365-79(Dec 1971). (In Russian).

In connection with applications of the ladder representations the question about the completeness of a set of commuting operators with a definite physical interpretation is investigated. A suitable transformation of these operators is introduced, by means of which the problem under consideration is reduced to investigation of a system of functional equations. A number of theorems about this system are proved, from which the completeness of the mentioned set follows. As a result, it is established that the ladder representations of the Lie algebra of U(6,6) can be given in terms of a physical complete set of commuting operators. (auth)

13740 PARABOSON REPRESENTATIONS OF THE Sp_{4R} ALGEBRA AND THEIR REDUCTION WITH RESPECT TO THE $O_{3,1}$ SUBALGEBRA. Alabiso, C.; Duimio, F. (Univ., Parma, Italy. Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cim.; 7A: No. 1, 163-79(1 Jan 1972).

The class of irreducible representations (IR's) of the $Sp_{4R} \sim O_{3,2}$ algebra (belonging to the discrete series), which can be constructed in the Hilbert–Fock space of two paraboson oscillators is constructed. In the case of order of parastatistics 1 (boson case) the two IR's of the Sp_{4R} algebra which can be constructed remain irreducible with respect to the $O_{3,1}$ subalgebra. For any other order of parastatistics, three IR's of the Sp_{4R} algebra appear and their reduction with respect to the $O_{3,1}$ subalgebra implies an infinite continuous direct sum of IR's of the homogeneous Lorentz algebra belonging to the principal series. Particularly, for the order of parastatistics 2, such a decomposition is directly connected with the problem of the diagonalization of a noncompact generator of the $O_{2,1}$ algebra in the IR's of the Bargmann discrete series ($D^{\pm}_{k}$). Possible applications of the results to the theory of the relativistic equations are indicated. (auth)

13741 MIXING OF RELATIVISTIC INVARIANCE WITH INTERNAL SYMMETRY. Westenholz, C. v. (Univ., Muenster, Ger.). Acta Phys. Austr.: 32: No. 3-4, 254-61(Mar 1970).

The following theorem is proven: Let E be a Lie group-symmetry which contains the inhomogeneous Lorentz group P_+ and some n-dimensional internal symmetry group G. Suppose this group to be an exact symmetry: $E = G \times P_+\uparrow$. A selfadjoint mass-breaking operator is considered, whose expectation values are by definition equal to the mass differences Δm between the mass levels, i.e., the spectrum of this operator as well as the one of the energy-momentum vector lies in $\{p = 0\}\ U\overline{V}^+$. Then the breakdown of the symmetry G may be characterized by the following equivalent statements: The direct product coupling $E = G \times P_+\uparrow$ is carried over in nontrivial mixings $E'_\alpha = G \perp_\alpha P_+\uparrow$. The theory remains invariant only under an internal symmetry G_1 of smaller dimension. The mass degeneracy is removed. (auth)

13742 EQUAL-TIME COMMUTATORS AMONG GENERATORS FOR BROKEN CONFORMAL AND INTERNAL SYMMETRIES. Gatto, R.; Sartori, G. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim.; 7A: No. 1, 99-117(1 Jan 1972).

General properties of broken conformal and internal symmetries are analysed. The commutator algebra of the generators of conformal and internal symmetry transformations are derived in the presence of breaking under general assumptions. The definition of the energy-momentum tensor is examined. General schemes of conformal and internal symmetry breakings are discussed and their algebraic properties derived. (auth)

13743 P- AND T-VIOLATIONS IN ATOMIC PHYSICS. Commins, E. D. (Univ. of California, Berkeley). pp 25-32 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From 2. international conference on atomic physics; Oxford, England (21 Jul 1970).

A discussion is presented as to why physicists carry on a search for P and T violations so intensively, under the following headings: CP violation (method of detailed balance; "triple scalar product corrections" in weak and in some cases electromagnetic interactions; static electric dipole moments of elementary particles); parity violation in nuclear forces; what does atomic physics have to do with P and T? (electric dipole moments of elementary particles; triple correlation ($^9Ne^{19} \cdot p_e \times p_\nu$) in the mirror decay $^{19}N \rightarrow {}^{19}F + e^+ + \nu$; search for parity violation in nuclear forces by observation of fore–aft symmetry in the 279 keV γ transition of polarized ^{203}Tl; parity violation effects in β-decay). (28 references)

13744 ONE-PARTICLE OPERATORS AND LOCAL INTERNAL SYMMETRIES. Herbst, Ira W. (Univ. of California, Berkeley). J. Math. Phys. (N. Y.); 12: No. 12, 2480-90(Dec 1971).

The structure of local operators linear in the creation and destruction operators of a finite number of particles is investigated. It is shown that these operators determine a set of local and relatively local free fields relative to which the original operators are local. This result is used to study local internal symmetries in a theory of interactions and to show that these symmetries commute with the Lorentz group. The assumptions of Haag and Ruelle which lead to a complete particle interpretation are also discussed. Asymptotic many-particle states are constructed under less restrictive assumptions. (auth)

13745 GROUP OF TWO-PARTICLE COLLISIONS IN CLASSICAL AND RELATIVISTIC KINETIC THEORIES. Marle, C. (Univ., Besancon, France). Compt. Rend., Ser. A; 273: No. 20, 950-2(15 Nov 1971). (In French).

The collisions between two particles may be mathematically described by an operation of the SO(3) group on an appropriate variety (E(6) in classical theory, $\Omega \times \Omega$ in relativistic theory, Ω being the mass hyperboloid). (France)

Applications (Electromagnetic and Weak)

13746 INTRODUCING SCALE SYMMETRY. Jackiw, Roman (Massachusetts Inst. of Tech., Cambridge). Phys. Today; 25: No. 1, 23-7(Jan 1972).

An introduction is given to scale symmetry as a useful symmetry for high-energy physics. The application to MIT-SLAC experiments on deep-inelastic electron scattering off nucleons is described. Applications to other processes are also discussed. (L.B.S.)

13747 MICROSCOPIC IRREVERSIBILITY IN THE NEUTRAL KAON SYSTEM AND THE THERMODYNAMICAL ARROW OF TIME. II. CPT VIOLATING CASE. Aharony, Amnon (Tel-Aviv Univ., Ramat Aviv, Israel). Ann. Phys. (N. Y.); 68: No. 1, 163-71(Nov 1971).

The expression for the entropy production in the decay of a neutral kaon interacting with a thermal bath of bosons, introduced previously, is reformulated without assuming CPT conservation. The relation between the sign of Re ϵ and the thermodynamical arrow of time is further discussed, and the ambiguity due to the definitions of matter-antimatter is resolved. (auth)

Applications (Strong)

13748 (LBL–500, pp 153-6) POLARIZATION EXPERIMENTS IN NUCLEON–NUCLEON SCATTERING TO TEST TIME-REVERSAL INVARIANCE. Bryan, R. A. (Texas Agricultural and Mechanical Univ., College Station, Dept. of Physics); Gersten, A. (Nijmegen Univ. (Netherlands)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Calculations for nucleon–nucleon polarization minus asymmetry and $P_A - P_B$ due to a T-violating model are presented at 50, 142, 425, and 635 MeV. Arguments are made that the angular distributions are correct for any short-range T-violating mechanism. (auth)

13749 LORENTZ-INVARIANCE ALGEBRAIZATION OF HADRON VERTEX FUNCTION IN SU(3). Cheung, F. F. K.; Wang, M. Y. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 4: No. 10, 3217-20(15 Nov 1971).

It is shown that, in the exact SU(3) limit and under plausible assumptions, the matrix elements of the SU(3) axial-vector currents taken between two hadron states at rest form a closed algebra isomorphic to SO(9,3). Some remarks are made on previous results for SU(2) axial-vector currents. (auth)

13750 SPIN AND INTERNAL SYMMETRY IN THE DUAL RESONANCE MODEL. Bars, Itzhak. New Haven; Yale Univ. (1971). 85p. University Microfilms Order No. 71-28,024.

Thesis.

A consistent formalism is developed in the context of the dual resonance model, which assigns to the external particles quantum numbers such as spin, parity, charge conjugation, isospin and strangeness, as well as unequal masses. This formalism is based on broken SU(12) symmetry, and does not suffer from tachyons, ghosts, unphysical degeneracies or unphysical cuts. It is assumed that the amplitude can be written as a sum of permutations of terms related to definite orderings of the external particles. Then, it is shown that the assumptions of SU(3) invariance, absence of exotic states, duality and factorization uniquely determine the SU(3) content of each permutation as a multiplicative factor given as $\mathrm{Tr}(\lambda^{a_1}\lambda^{a_2}\ldots\lambda^{a_n})$. Spin, parity and charge conjugation are also introduced similarly through traces of 4×4 Dirac matrices, in a way which avoids ghosts and tachyons. A systematic program for breaking the degeneracy due to the SU(12) symmetry is proposed and carried out in detail. Finally, a generalization of all these results is given for the n-point function, in terms of single diagrammatic rules. (Diss. Abstr. Int., B)

Field Theories

General

13751 AXIALSYMMETRIC STATIONARY SOLUTIONS OF THE PROJECTIVE FIELD THEORY. Kramer, D. (Friedrich-Schiller Univ., Jena, Ger.). Acta Phys. Pol.; B2: No. 6, 807-11 (Nov-Dec 1971). (In German).

Starting with an arbitrary axialsymmetric stationary solution of Einstein equations describing the exterior field of an isolated uncharged source a corresponding class of such solutions of the projective field theory is constructed. Outside a finite region the regularity conditions on the axis of symmetry are satisfied. The method is applied to Kerr metric. Electromagnetic fields are not investigated. (auth)

13752 INVARIANCE PROPERTY OF FIELD THEORIES. Hall, G. S. (Univ. of Newcastle upon Tyne, Eng.). Acta Phys. Pol.; B2: No. 6, 715-21(Nov-Dec 1971).

A new invariance property of tensorial functions of the field variables ψ_A and their derivatives is presented. This invariance arises from the possibility of replacing the partial derivatives of ψ_A by covariant derivatives with respect to a symmetric second order tensor $\gamma_{\mu\nu}$ possessing properties similar to that of a flat space-time metric tensor. The resulting identities and conservation laws are then discussed. As an example the theory is applied to the Ricci scalar curvature invariant in general relativity and the resulting conservation law turns out to be the Rosen–Papapetrou identity. In the final section the new method is compared with the more usual Noether method and the differences are given interpretation. (auth)

13753 AXIAL VECTOR VERTEX IN SPINOR ELECTRODYNAMICS AND THE ANALYTIC REGULARIZATION METHOD. Fanchiotti, H.; Garcia Canal, C. A.; Girotti, H. O.; Vucetich, H. (Univ. of La Plata). Lett. Nuovo Cim.; 3: No. 1, 9-16(1 Jan 1972).

Some specific features of the axial vector vertex in spinor electrodynamics are re-examined in the light of the analytic regularization method in its gauge-invariant version given by Breitenlohner and Mitter (Nuclear Physics, 7B, 443, 1968) to deal with closed fermion loops. (J.F.P.)

13754 ELECTRODYNAMICS IN A STRONG MAGNETIC FIELD. Rassbach, Michael Eric. Pasadena, Calif.; California Inst. of Tech. (1971). 71p. University Microfilms Order No. 72-483.

Thesis.

A study is made of the electrodynamic phenomena which can occur in strong magnetic fields (on the order of 4.41×10^{13} gauss). These phenomena are studied by means of a perturbation formalism, developed to be exact to all orders in the field strength, and which is closely analogous to the diagrammatic formalism of empty-space electrodynamics. Using this method, the rate for pair production by single photons is calculated, as well as an approximation to it. The index of refraction of the strong field region is also calculated, as is the low-frequency photon splitting amplitude. In addition, some phenomena are studied occurring at very high field strengths, in particular the energy of the ground state to first order in the fine-structure constant, and the counter-intuitive nonannihilating states. Numerical calculations are made where relevant. (Diss. Abstr. Int., B)

13755 EQUATIONS GOVERNING THE ENERGY-MOMENTUM TENSOR OF A SYSTEM OF CHARGED PARTICLES. Stettner, R. (Univ. of Chicago). Ann. Phys. (N. Y.); 68: No. 1, 281-301(Nov 1971).

The equations governing the energy, momentum, and angular momentum of a system of charged particles in motion are obtained as a series in inverse powers of c. The mass motion and time-symmetric part of the retarded electromagnetic field are shown to contribute to these equations a total time derivative which is an even power series in c^{-1}. The radiation-reaction terms of $O(c^{-5})$ are evaluated and discussed as a prototype for higher-order, odd-power terms in the asymptotic expansions of the equations. (auth)

13756 CURRENTS IN CLASSICAL FIELD THEORIES. Hermann, Robert (Rutgers–The State Univ., New Brunswick, N. J.). J. Math. Phys. (N. Y.); 13: No. 1, 97-9(Jan 1972).

The current vector field associated with a one-parameter group of transformations of a classical field is defined in a coordinate-free way. (auth)

13757 CONDITION FOR VANISHING ELECTROMAGNETIC SELF-STRESS IN NONLINEAR CLASSICAL ELECTRODYNAMICS. Rafelski, J.; Fulcher, L. P.; Greiner, W. (Univ., Frankfurt am Main). Nuovo Cim.; 7B: No. 1, 137-44(11 Jan 1972).

A condition for a vanishing electromagnetic self-stress is established, which also leads to a finite electromagnetic self-energy. Maxwell's theory does not satisfy this requirement. A class of nonlinear theories, which includes that of Born and Infeld, satisfies the condition. (auth)

13758 FORCE-FREE MODES, WORK-FREE MODES, AND RADIATIONLESS ELECTROMAGNETIC FIELD CONFIGURATIONS. Erber, T. (Illinois Inst. of Tech., Chicago); Prastein, S. M. Acta Phys. Austr.; 32: No. 3-4, 224-43(Mar 1970).

It is shown that there are accelerated motions of extended charge structures for which the radiation reaction vanishes identically. The force-free condition is equivalent to a constraint which links the form factors of the sources to the dynamics of the motion. Work-free modes are periodic motions for which the energy integral $\oint \mathbf{F}_{self}\cdot \mathrm{vdt}$ vanishes identically. Form factor constraints corresponding to work-free modes are also derived explicitly. The general relation between force-free modes and work-free modes is discussed. The weakest form-factor restrictions are associated with motions in which no net energy is transferred to the far-field radiation zone. It is shown that these radiationless electromagnetic field configurations arise in cases where the characteristic field oscillators have resonances which coincide with zeros of the form factors of the sources. (auth)

Quantum Field Theory

Refer also to abstracts 13197, 13472, 13577, 13579, 13629, 13630, 13660, and 13733.

13759 (JINR-P2-6128) RELATION BETWEEN PARA-FERMI STATISTICS AND ORDINARY FERMI STATISTICS. Govorkov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

One can clarify the hardly comprehended correspondence between the first- and second-quantized theories of paraparticles realizing the fact that the parafield describes nonidentical particles. (auth)

13760 REALISATIONS OF THE REPRESENTATIONS OF PARA-FERMI ALGEBRA IN FOCK SPACE OF BOSE OPERATORS. PART II. Kademova, K. (International Centre for Theoretical Physics, Trieste, Italy); Kalnay, A. J. Int. J. Theor. Phys.; 3: No. 2, 115-18(Apr 1970).

Using the method given in Part I of this series Green's isomorphisms of the para-Fermi algebra F_{2n}^{1} with 2n generators into $\epsilon_{2n+1}^{q(2)}$ are constructed. All the representations of the para-Fermi algebra are realized in Fock space H_{2n}^{1} of 2'' Bose operators. (auth)

13761 EQUATIONS GENERATED BY MEANS OF PARAFIELD OPERATORS. Kademova, K. V. (Inst. of Physics, Sofia). Int. J. Theor. Phys.; 3: No. 5, 355-8(Oct 1970).

It is shown that using realizations of Lie algebras with parafield operators one can generate infinitely many classes of invariant equations corresponding to each order of parastatistics p. (auth)

13762 HIGH-ORDER REALIZATIONS OF THE PARA-FERMI ALGEBRA WITH PARAFIELD OPERATORS. Kademova, K. V. (Inst. of Physics, Sofia). Int. J. Theor. Phys.; 3: No. 4, 295-8(Aug 1970).

Using second-order realizations of Lie algebras by means of creation and annihilation parafield operators the generators of the para-Fermi algebras are expressed as high-order polynomials of para-Bose or para-Fermi creation and annihilation operators. (auth)

13763 REALIZATIONS OF THE REPRESENTATIONS OF PARA-FERMI ALGEBRA IN FOCK SPACE OF BOSE OPERATORS. PART I. Kademova, K. (International Centre for Theoretical Physics, Trieste, Italy). Int. J. Theor. Phys.; 3: No. 2, 109-14(Apr 1970).

Using the matrix realizations of para-Fermi operators isomorphic mappings are found with respect to the Green product of the para-Fermi algebra into second-order polynomials of creation and annihilation para-Bose operators with arbitrary order of parastatistics. In the Fock space $\mathcal{H}_1^1$ of two Bose operators all the irreducible representations of the para-Fermi algebra are realized. The spaces of n-particle Bose states n = 1, 2, ..., from which $\mathcal{H}_1^1$ is constructed as a direct sum, can be interpreted as spaces of para-Fermi states of para-statistics n. (auth)

13764 TENSORIAL REPRESENTATION OF THE DIRAC EQUATION. Muraskin, Murray (Univ. of North Dakota, Grand Forks). Int. J. Theor. Phys.; 3: No. 1, 33-9(Feb 1970).

Tensor representations of the Dirac equation are discussed, using a geometric approach. It is found that the mass zero Dirac equations can be represented by Maxwell equations having a source that obeys the empty-space wave equation. A relation is also obtained for the source in terms of E and H. In the case of mass not equal to zero, a difficulty is encountered in removing the constant spinors χ_A and $\bar{\varphi}_{\dot{A}}$. It is found that the arbitrary constant spinors can be eliminated in a spinor theory based on the Klein–Gordon equation. (auth)

13765 NONLOCAL THEORY OF SCALAR FIELDS. Tran Hu'u Phat (Hanoi Univ., Viet-Nam). Acta Phys. Pol.; B2: No. 6, 763-70(Nov-Dec 1971).

A nonlocal theory of scalar fields is considered. In this theory, by using generalized analytic functions the ultraviolet divergences are eliminated without any regularization. S-matrix satisfying the unitary and macrocausality conditions is constructed. (auth)

13766 UNIVERSAL REGULATOR? Tran Hu'u Phat (Hanoi Univ., Viet-Nam). Acta Phys. Pol.; B2: No. 6, 753-61(Nov-Dec 1971).

By using the Goldstone's theorem, a universal regulator is discovered, i.e. the cosmic field being the Yang–Mills field of the local scale transformations of space-time coordinates. Its physical role is as follows. Cosmon, the quantum of cosmic field, is a vanishing rest mass, spinless and neutral particle. It is a universal particle in the sense that it participates in all the physical processes, carrying the interactions in the acausal region G_1 and moreover, if its presence is taken into account, then interactions become microcausal and the theory is free of all the ultraviolet infinities. (auth)

13767 LOCAL COMMUTATIVITY FOR NONLOCALISABLE FIELDS. Taylor, J. G. (Univ. of Southampton, Eng.). Ann. Phys. (N. Y.); 68: No. 2, 484-98(Dec 1971).

A definition of local commutativity for nonlocalizable field theory is given by means of a limiting procedure for the Wightman functions of the theory; it includes, as a special case, rational functions of the free field. Fields for which this limiting procedure is defined are shown to satisfy many of the desirable features of localizable fields, including the existence of a TCP operator, the cluster property, the existence of asymptotic limits, and the LSZ reduction formulas. A strengthening of the procedure allows forward scattering dispersion relations to be obtained; the effects of nonlocalizability on rigorous high energy bounds are also considered. (auth)

13768 QUANTIZATION OF SPACE–TIME AND GENERALIZATION OF THE DIRAC EQUATION: INTERPRETATION OF AN ADDITIONAL DEGREE OF FREEDOM. Meessen, A. (Univ. Catholique, Louvain, Belg.). Ann. Soc. Sci. Brux. Ser. I; 85: No. 2, 204-20(25 Aug 1971). (In French).

The introduction of an elementary length (a), defining the ultimate limit for the measurable distance, implies that Dirac's differential equation has to be replaced by a corresponding finite-difference equation. This generalized Dirac equation requires, however, the introduction of spinors with eight instead of the usual four components. It is shown that one has actually two four-component spinors, whose amplitudes are defined, respectively, for two possible sets of eigenvalues of the time variable, ct being an integer or a half-integer multiple of the quantum of length a. Moreover, it appears that the two spinors can "vibrate" in phase or in opposite phase, so that the additional degree of freedom is analogous to the possible occurrence of "acoustical" and "optical" modes for the vibrations of a crystal lattice. The corresponding spinor-eigen-states are characterized, however, by the same energy-momentum relation, defining a new internal degree of freedom, which remains still degenerate in the presence of an electromagnetic field. It is only in the case where the quantum of length is identically zero, that one gets a single four-component spinor. (auth)

13769 FERMIONS AND BOSONS IN A TWO-DIMENSIONAL WORLD. Freundlich, Y. (Tel-Aviv, Univ., Israel). Nucl. Phys.; B36: No. 2, 621-33(1972).

The formal equivalence of a free massless two-dimensional theory and a free massless two-dimensional boson theory constructed from the bilinear products of the self-same fermion theory. The sense of this equivalence is investigated. Using a box normalization, it is found that the fermion states are Glauber coherent states of bosons, where the boson vacuum is the ground state of the charge sector corresponding to the given fermion state. The massless boson is the Goldstone boson and the degenerate vacua are the ground states of the various charge sectors. A complete operator identity between fermion and boson operators can be obtained, but to do this an additional boson operator must be introduced which cannot be defined in terms of bilinear products of the fermion operators. Doing this makes the charge spectrum continuous. (auth)

13770 STUDIES ON THE FINITE QUANTUM ELECTRODYNAMICS FOR SPIN-ZERO BOSON. Kim, Ick-joh. Rochester, N. Y.; Univ. of Rochester (1971). 91p. University Microfilms Order No. 72-730.

Thesis.

However, the present situation in spinor electrodynamics seems to be quite uncertain with regard to the charge renormalization constant. Motivated by this fact, an attempt was made to investigate the possibility of having a finite theory for the spin zero boson case. After a review of the renormalization group the equation for the Green's function is derived from the Lagrangian. There, it has also been shown that the Green's function is finite in the Yennie gauge to second order in e_0. The equations for the one-photon and two-photon vertex functions are derived separately, and the Ward identity is discussed in general terms. At the same time, it is also demonstrated explicitly that the equations for the Green's function and vertex function to second order in e_0 satisfy the Ward identity. From this, it is concluded that the renormalization constants Z_2 (wave function), Z_1 (one-photon vertex) and Z_4 (two-photon vertex) are equal and finite in the Yennie gauge to lowest order. In addition, from considerations of infrared divergences the coefficient g_0 of the ϕ^4 term in the Lagrangian is determined to be $g_0 = -e_0^3$. This result agrees with that of Fry who adjusted g_0 in such a way that the divergences from meson–meson scattering in the higher order contribution to the two-photon vertex function are cancelled. The vacuum polarization tensor is derived from the current defined as a separated point limit and its gauge invariance is proved. The divergent contribution of the charge renormalization constant Z_3 is calculated. The Tschebyscheff polynomial expansion is applied throughout the calculation. The final result shows that there is no possibility of having finite renormalization to fourth order in the charge e_0. (TSS) (Diss. Abstr. Int., B)

13771 ABSENCE OF NONCANONICAL BEHAVIOR IN QUANTUM ELECTRODYNAMICS. Khan, Irshadullah (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 4: No. 10, 2977-83(15 Nov 1971).

Using the explicit electromagnetic-field-dependence property of the electromagnetic current according to Schwinger and Johnson, a perturbation-theoretic calculation of equal-time canonical current commutators is carried out to show that there are no noncanonical derivative terms bilinear in the electromagnetic field, contrary to what has been claimed in the past. This result is in accord with that of the Bjorken–Johnson–Low definition for equal-time commutators. It is pointed out that the conventional distribution-theoretic approach to handling singular expressions of field multilinears at the same space-time point fails to take into account field-dependence properties of the kind present in the Schwinger–Johnson ansatz. (auth)

13772 SUBTRACTED SPECTRAL REPRESENTATIONS AND SINGULAR EQUAL-TIME COMMUTATORS. Nutbrown, D. A. (Univ. of Rochester, N. Y.). Phys. Rev., D; 4: No. 10, 3035-8(15 Nov 1971).

The question of subtractions in a spectral representation is considered which should be regarded as a dispersion relation in energy (the Low equation) for the true propagator function, rather than as a dispersion relation in the square of the momentum for some suitably covariantized version. It is demonstrated how a generalization of the theorem of Bjorken, Johnson, and Low to subtracted spectral representations yields a vacuum expectation value of the equal-time commutator which, together with the propagator function, satisfies a sequence of partial differential equations in momentum space. It is found that the commutator corresponding to a subtracted representation contains singular terms which are not completely specified by the spectral functions. As an application any model in which currents are represented by bilinear forms of free spinor fields is considered. There such singular terms can invalidate, for example, the usual statement of universality of weak interactions and the simple $SU_3 \times SU_3$ algebra of quark charges. (auth)

13773 QUANTUM ELECTRODYNAMICS WITHOUT PHOTON SELF-ENERGY PARTS: AN APPLICATION OF THE CALLAN–SYMANZIK SCALING EQUATIONS. Adler, Stephen L. (Inst. for Advanced Study, Princeton, N. J.); Bardeen, William A. Phys. Rev., D; 4: Nb. 10, 3045-54(15 Nov 1971).

In a series of recent papers, Johnson, Baker, and Willey study quantum electrodynamics with internal photon self-energy parts omitted. They find that in this model the asymptotic electron and photon propagators have remarkable, simple properties. It is shown that these properties can be derived in a very economical fashion by using the Callan–Symanzik scaling equations. (auth)

13774 ROLE OF INTERACTING REGGEONS IN FIELD-THEORETIC INVESTIGATIONS OF HIGH-ENERGY SCATTERING. Kogut, John B. (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 10, 3101-13(15 Nov 1971).

Using infinite-momentum perturbation theory Regge exchange and the Regge-eikonal approximation in field theory are discussed. This calculational technique enjoys a simple physical picture which is a realization of Feynman's parton ideas. It allows a simple space-time interpretation of the popular Regge-eikonal approximation which treats Reggeons as noninteracting, noninterfering units to be presented. However, the calculational scheme suggests that it is not reasonable to treat Reggeons as noninteracting entities. In fact, using integral-equation techniques, a set of graphs involving interacting Reggeons is calculated and it is found that they give rise to a scattering amplitude which grows faster with energy than single Reggeon exchange. The implications of this result outside the calculational scheme presented here are discussed. (auth)

13775 THRESHOLD BEHAVIOR OF REGGE TRAJECTORIES IN A SIMPLE FIELD-THEORETIC MODEL. Balakrishnan, V. (Brandeis Univ., Waltham, Mass.). Phys. Rev., D; 4: No. 10, 3205-13(15 Nov 1971).

The threshold behavior of the trajectory function in $g\varphi^3$ field theory in the ladder approximation is reconsidered. A brief pinch analysis indicates how the elastic and inelastic thresholds arise. Working directly in the angular momentum plane, the "accumulation" of Regge poles near the "promoted" value $l = -\frac{1}{2}$ when $s \to 4m^2$ is demonstrated in a simple manner, starting from the homogeneous Bethe–Salpeter equation. (auth)

13776 INFINITELY COMPOSITE PARTICLES AND THE CONDITION Z = 0. Jouvet, B. (College de France, Paris); Whippman, M. Phys. Rev., D; 4: No. 10, 3222-3(15 Nov 1971).

In a recent paper, Whippman suggested that the usual procedure of letting the wave-function renormalization constant of a particle tend to zero did not provide bootstrap conditions for an infinitely composite particle, but led either to an identity or to an equation with no real solution. An explicit counterexample to this hypothesis is presented. (auth)

13777 CHIRAL INVARIANCE AND THIRRING MODELS. Ciccariello, S. (Univ., Padua, Italy. Istituto Nazionale di Fisica Nucleare, Padua). Lett. Nuovo Cim.; 2: No. 24, 1223-7(11 Dec 1971).

The solution to a scale and U(2) × U(2) invariant Thirring model is considered. It is shown that this model does not have any symmetrical solution such that Wilson's operatorial expansion and the Johnson definition for the currents hold unless the coupling constant g equals zero. (L.B.S.)

13778 QUANTUM ELECTRODYNAMICS IN TWO DIMENSIONS. Lowenstein, J. H.; Swieca, J. A. (Univ. of Sao Paulo, Brazil). Ann. Phys. (N. Y.); 68: No. 1, 172-95(Nov 1971).

Operator solutions of the Schwinger model are given in several gauges. The correct interpretation for the covariant solution with indefinite metric is discussed. A class of noncovariant gauges, particularly well suited to the analysis of the gauge-invariant algebra is obtained. As a result of this analysis, it is seen that there are no physical electron excitations in the model. Charge sectors can be introduced, but only at the price of violating the spectrum condition. The Coulomb gauge solution is shown to lead to a very pathological indefinite metric. Quantum electrodynamics as limit of a vector meson theory and broken symmetry aspects are discussed in the concluding sections. (auth)

13779 RENORMALIZATION OF THE ONE-SPACE DIMENSIONAL YUKAWA MODEL BY UNITARY TRANSFORMATION. Federbush, Paul (Univ. of Michigan, Ann Arbor); Gidas, Basilis. Ann. Phys. (N. Y.); 68: No. 1, 98-101(Nov 1971).

A unitary transformation is used to renormalize the one-space dimensional Yukawa model in a box. A momentum cut-off dependent sequence of unitary transformations is constructed such that weak limit matrix elements of the transformed Hamiltonian exist between a dense set of states as matrix elements of a symmetric operator. (auth)

13780 RENORMALIZATION OF SOME ONE-SPACE DIMENSIONAL QUANTUM FIELD THEORIES BY UNITARY TRANSFORMATION. Federbush, Paul (Univ. of Michigan, Ann Arbor). Ann. Phys. (N. Y.); 68: No. 1, 94-7(Nov 1971).

The one-space dimensional $\varphi^m \bar{\psi}\psi$ interaction is renormalized by unitary transformation. A uniformly convergent sequence of unitary operators is defined which transforms the sequence of cut-off Hamiltonians, arranged in order of increasing cut-off energy, to a sequence of operators converging strongly on a dense set of states. (auth)

13781 NON-L^2 SOLUTIONS OF EXACTLY SOLUBLE RELATIVISTIC WAVE EQUATIONS AND THE LEE MODEL. Nelson, C. A.; Rajagopal, A. K. (Louisiana State Univ., Baton Rouge). J. Math. Phys. (N. Y.); 13: No. 1, 73-8(Jan 1972).

In nonrelativistic potential theory there can exist singularities of the S matrix which are associated with wave functions belonging to a non-L^2 class. The non-L^2 character of these singularities is shown to persist in several relativistic models: In (1) two schemes, including that of the Klein–Gordon equation and the coupling of a classical relativistic field to an external exponential source, in (2) the pair theory, classical and quantized, with separable interactions, and in (3) the Lee model. For (2) and (3), poles of the "proper" Jost function $\tilde{f}$-(k,0), i.e., the Fredholm determinant for the outgoing scattering state, correspond to non-L^2 class solutions of the associated dynamical field equation in coordinate space. These non-L^2 solutions will be called "shadow" fields. They are of special importance and bear the same relation as the "shadow" states in potential theory because they also are of dynamical origin and do not appear in the completeness or unitarity relations by virtue of their non-L^2 status. (auth)

13782 CANONICAL COMMUTATION RELATIONS AND INFINITE-DIMENSIONAL MEASURES. Hegerfeldt, Gerhard C. (Univ., Goettingen, Ger.). J. Math. Phys. (N. Y.); 13: No. 1, 45-50(Jan 1972).

Recently, Araki has proved ray continuity for the measure-space realization of the CCR's. Stronger continuity properties of this realization are derived, from which Araki's result follows as a corollary. It is shown that V(g) is continuous on complete metric subspaces of U_π for any metric stronger than the weak topology. Surprisingly no further assumptions on the measure are needed. If U_π is an F- or LF-space, V(g) is continuous on the whole of U_π. These results are equivalent to certain continuity properties of the Radon–Nikodym derivative of the measure. Via these, it is then shown that every quasi-invariant measure on a nuclear F- or LF-space, such as S or D, is a superposition of ergodic measures. In the derivation, their close connection with irreducible representations of the CCR's is exploited. (auth)

13783 DILATATION AND CONFORMAL INVARIANCE ON NULL PLANES. Rohrlich, F.; Streit, L. (Syracuse Univ., N. Y.). Nuovo Cim.; 7B: No. 1, 167-74(11 Jan 1972).

It is proven that a relativistic scalar field whose null-plane restriction exists ($Z_2^{-1} < \infty$), and which has c-number commutation relations there, transforms covariantly under dilation and conformal transformations on a null plane. These transformations are thus unitarily implementable. The restriction of the conformal algebra to the null plane is discussed. (auth)

13784 UNIVERSAL NOETHER'S NATURE OF INFINITESIMAL TRANSFORMATIONS IN LORENTZ-COVARIANT FIELD THEORIES. Candotti, E. (Univ., Naples); Palmieri, C.; Vitale, B. Nuovo Cim.; 7A: No. 1, 271-9(1 Jan 1972).

It is shown that any Noether transformation (namely an infinitesimal transformation to which a continuity equation can be related) can be put in a form that will relate it to any other continuity equation satisfied by the dynamical system under

study, and that, should a Noether transformation exist for a given dynamical system, all other infinitesimal transformations will turn out to be of Noether form. There is, therefore, between the class of all infinitesimal transformations and the class of all continuity equations, a more abstract and a deeper relationship than the one of which Noether's theorem bears evidence. In particular it is shown how to reduce to explicit Noether form all infinitesimal transformations operating on a dynamical system described by a Lorentz-invariant Lagrangian density. (auth)

13785 GENERALIZED EQUAL-TIME COMMUTATORS. Krause, F. (Univ., Bonn). Nuovo Cim.; 7A: No. 1, 71-98 (1 Jan 1972).

An expansion of causal distributions is proposed which shows explicitly the structure of these distributions in the "equal-time" limit. It is shown that such an expansion always exists for matrix elements of a commutator in a local axiomatic field theory. The expansion is suitable for the study of the range of applicability of the manipulations usually performed with the equal-time commutators (like construction of field-charge commutators and differentiation of retarded commutators). Furthermore, it is shown how one can extend these manipulations to cases where equal-time commutators (in the usual sense) do not exist. The expansion is used to study some of the restrictions which are implied by locality on the structure of current commutators. (auth)

13786 CONDITIONS OF THE CONSISTENCY, COMPLETENESS, AND RELATIVISTIC INVARIANCE OF THE SYSTEM OF EQUAL-TIME COMMUTATORS. Shirokov, Yu. M. (Mathematical Inst., Moscow). Teor. Mat. Fiz.; 9: No. 3, 333-42 (Dec 1971). (In Russian).

The problem of obtaining the necessary and sufficient conditions, which ensure the consistency, completeness and relativistic covariance of the system of equal-time commutators is stated and solved. The difficulties arise from the fact that the system of the commutators is cumbersome and put down in a noncovariant form. These difficulties are tackled by the functorial transition from the category of quantum fields into the category of universal algebras. In the universal algebra each local quantity is represented by the corresponding element of the algebra. The elements of the algebra have no coordinate dependence. Each equal-time commutator is represented by the finite set of various nonassociative multiplications. The energy stress tensor has to be included into the system of commutators for deriving the relativistic invariance conditions. (auth)

13787 TRANSLATIONALLY INVARIANT LIMIT OF THE LEE MODEL. II. Dadashev, L. A. (Inst. of Physics, Baku). Teor. Mat. Fiz.; 9: No. 3, 305-17(Dec 1971). (In Russian).

It is shown that the translationally invariant limit of the boson field in the Lee model exists and is equal to the free field. As a result, the translationally invariant scattering matrix exists also, but it is equal to the identity. The calculation of the same matrix by the standard perturbation theory procedure gives rise to divergent expressions. This means that one has demonstrated in the particular case that the divergencies of the quantum field theory can be caused by using the perturbation theory. (auth)

13788 ASYMPTOTICAL FIELDS IN THE APPROXIMATED RENORMALIZED TWO-DIMENSIONAL YUKAWA MODEL. Yakymiv, Ya. M. (Inst. of Theoretical Physics, Kiev). Teor. Mat. Fiz.; 9: No. 3, 323-32(Dec 1971). (In Russian).

The renormalized Yukawa theory in the two-dimensional space-time is considered. The existence of asymptotical limits of the creation-annihilation operators is proved. It is also shown that the commutation relations of these asymptotical operators with the total Hamiltonian are of the same form as those of the usual creation-annihilation operators with the free Hamiltonian. This provides some information about the spectrum of the total Hamiltonian. (auth)

13789 REGULARIZATION OF THE EQUATIONS OF SELF-INTERACTING NEUTRAL SCALAR QUANTUM FIELD IN THE CASE OF TWO SPATIAL DEGREES OF FREEDOM. Zastavenko, L. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 9: No. 3, 355-64(Dec 1971). (In Russian).

The method developed earlier is applied to the more complicated case of two spatial coordinates. The equations for the ground and excited states are of the same form as in the one-dimensional case, but the integrations are substituted by double ones. The divergencies more complicated than those in the one-dimensional case arise. However they can be avoided by means of extracting a certain special factor from the eigen-functional Ω of the energy operator H. (auth)

13790 PRESENT AND FUTURE STATE OF QUANTUM ELECTRODYNAMICS. Brodsky, S. J. (Cornell Univ., Ithaca, N. Y. Stanford Univ., Calif.). pp 1-24 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

A review is presented of the most recent developments in precision tests of quantum electrodynamics. It is stated that the subject has reached the state where none of the crucial tests indicates any serious discrepancy with its predictions. Furthermore high energy–high momentum transfer experiments are now in essentially perfect agreement with theoretical predictions, and the Born approximation structure of the theory, that is, the validity of the Dirac current for the lepton and Maxwell's equation, has been verified to small distances approaching 10^{-15} cm. Headings are as follows: precision tests of quantum electrodynamics (the anomalous magnetic moments; the Lamb shift and fine structure of hydrogenic atoms; the hyperfine structure of hydrogenic atoms); and implications for fundamental physics. (67 references) (UK)

13791 DIRECT PARTICLES THEORY IN QUANTUM ELECTRODYNAMICS. Hoyle, F. (Cambridge Univ., Eng.). pp 371-82 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

It has been said that the time-symmetric classical electrodynamics of Dirac, symmetric with respect to advanced and retarded potentials, has not been made into a satisfactory equation theory. Hoyle, however, describes the attempt that he and Narlikar have made to develop a quantum theory of time-symmetric electrodynamics, which they claim to be successful. (2 references) (UK)

13792 APPROXIMATELY RELATIVISTIC INTERACTIONS. Kennedy, Frederick James (Univ. of Alberta, Edmonton). Amer. J. Phys.; 40: No. 1, 63-74(Jan 1972).

The well-known application of the Lorentz transformation to the exactly relativistic Coulomb force in order to derive the force on a charge due to another in uniform motion is extended to arbitrary Lorentz-invariant one-body problems. It is shown that the result, in addition to being the force on m_1 from uniformly moving m_2, is, to first order in coupling strength, the Lorentz-invariant force on m_1 when m_2 is unconstrained and the two particles interact. Some attention is paid to Lagrangians for exactly relativistic one-body problems, and a new construction of Darwin-like $1/c^2$ corrections to nonrelativistic Lagrangians for a variety of interactions is presented. Among these is the EIH Lagrangian of general relativity, whence follows an interesting point concerning special relativistic gravitation. (auth)

13793 SOME PROPERTIES OF PHYSICAL SYMMETRIES. Lopuszanski, Jan T. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. J. Math. Phys. (N. Y.); 12: No. 12, 2401-12(Dec 1971).

It is shown that each symmetry of a field theory with interaction and with a mass gap, induced by a local current, is also induced by at least two other currents, local with respect to the asymptotic free fields and bilinear in these fields. The currents are asymptotic currents in the sense of Araki and Haag [H. Araki and R. Haag, Commun. Math. Phys. 4, 77(1967)] of the original current. It is also shown that the charges, displaying spinorial transformation character with respect to the Lorentz group, vanish, while the tensorial charges are a linear combination of the scalar charges (internal symmetries) and the energy-momentum vector (translational symmetry). (auth)

13794 ELEMENTARY PARTICLES IN DE SITTER SPACE. Boerner, G. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Rend. Scu. Int. Fis. Enrico Fermi; 47: 362-4(1971).

The de Sitter space is used to aid in the development of a quantum field theory of particles in general Riemannian manifolds in the Minkowski space–time description. The model also reveals some of the changes expected to occur in quantum field theory when departing from flat space. (J.F.P.)

Gravitation and General Relativity

Refer also to abstracts 12819, 13008, 13106, and 13110.

13795 GRAVITATIONAL-SCALAR FIELD COUPLING. II. Higbie, James H. (Brandeis Univ., Waltham, Mass. Technion-Israel Inst. of Tech., Haifa). Ann. Phys. (N. Y.); 68: No. 2, 521-40(Dec 1971).

Particle-like solutions are sought for the system: gravitational field-electromagnetic field-massless scalar field-explicit source for all three fields. The scalar field is taken to be the ordinary minimally coupled field, the (nonminimally coupled) conformally invariant field, or the Brans–Dicke field. The conformally invariant field is found to eliminate the unpleasant behavior found previously for the minimally coupled field, providing the scalar charge is small enough. For all three systems, the presence of the scalar field introduces a constraint on the source parameters, necessary to allow initially static solutions. Roughly, it requires that the electric charge be less than the bare mass. Since this results in a predominance of attractive forces, there are no static solutions having nonvanishing exterior scalar fields. Thus a model for a scalar field-source particle is not possible with this approach. (auth)

13796 TACHYONS AND GRAVITATIONAL CHERENKOV RADIATION. Lapedes, Alan S.; Jacobs, Kenneth C. (Univ. of Virginia, Charlottesville). Nature (London) Phys. Sci.; 235: No. 53, 6-7(3 Jan 1972).

Tachyons—particles moving faster than c—should generate a cone of gravitational radiation, analogous to the Cerenkov emission of electromagnetic radiation. Such an effect and some of the consequences are discussed. (auth)

13797 TIME-DEPENDENT SOLUTIONS OF EINSTEIN'S EQUATIONS. Leibovitz, Clement (Univ. of Alberta, Edmonton). Phys. Rev., D; 4: No. 10, 2949-55(15 Nov 1971).

Spherically symmetric time-dependent solutions are presented. One class of solutions could represent the interior of an incompressible sphere undergoing at its surface a process of condensation or evaporation. A large class of solutions of the equation $T^1_4 = 0$ is also obtained. A generalization of the Oppenheimer–Snyder solution is found. Two solutions obeying an equation of state are described. (auth)

13798 SPHERES WITH TWO DENSITY DISTIRBUTIONS IN GENERAL RELATIVITY. Gehlot, G. L.; Durgapal, M. C. (Univ. of Jodhpur, India). Phys. Rev., D; 4: No. 10, 2963-5(15 Nov 1971).

Exact internal solutions were found for a massive sphere with two different density distributions. The density has its minimum at the surface, and it increases inversely as the square of the distance as we move towards the center. There is a core of constant density ρ_c and radius r = b. The restrictions imposed by pressure and density relations limit the solutions to certain values of n, the parameter which determines the Schwarzschild ratio of the sphere. (auth)

13799 TAUB-NUT (NEWMAN, UNTI, TAMBURINO) METRIC AND INCOMPATIBLE EXTENSIONS. Miller, J. G. (Princeton Univ., N. J.); Kruskal, M. D.; Godfrey, Brendan B. Phys. Rev., D; 4: No. 10, 2945-8(15 Nov 1971).

A Kruskal-like extension of the Taub-NUT (Newman, Unti, Tamburino) metric is given, clearly exhibiting the unusual properties of this metric. The new extension is incompatible with the extension of Misner and Taub, referred to as Taub-NUT space, and also with the further non-Hausdorff extension of the latter that has been proposed by various authors. The geodesic incompleteness of these various extensions is discussed. (auth)

13800 STRUCTURE OF RELATIVISTIC SPACES. Marathe, Kishore B. Rochester, N. Y.; Univ. of Rochester (1971). 99p. University Microfilms Order No. 72-745.

Thesis.

The techniques of global analysis and critical point theory as applied to pseudo-Riemannian manifolds are used to discuss the structure of spaces encountered in the theory of relativity—called relativistic spaces. Of particular interest are four-dimensional manifolds with fundamental tensor of signature (-,-,-,+) and with torsion free Levi–Civita connection Γ_g. These are the underlying manifolds of relativistic spaces. (TSS) (Diss. Abstr. Int., B)

13801 SOME SOLUTIONS TO THE VACUUM EINSTEIN EQUATIONS BY MEANS OF THE METHOD OF NORMED NULL BASES. Corrigan, Thomas Carney. Lafayette, Ind.; Purdue Univ. (1971). 76p. University Microfilms Order No. 72-1835.

Thesis.

In 1964 Kerr and Schild obtained a new class of solutions of Einstein's empty space field equations when the metric has the form $h_{AB} = g_{AB} + l_A l_B(0.1)$ The quantity g_{AB} is the metric of Minkowski space referred to Cartesian coordinates and l_A is a null vector field: $g^{AB}l_A l_B = 0$. In 1966 Edelen generalized Kerr and Schild's method to the general case in which the space with metric tensor g_{AB} is not necessarily flat and the full Einstein field equations are used, thus providing several more degrees of freedom. An application of Edelen's method of normed null bases to a specific case is given. The metric tensor g_{AB} is taken to be the metric of Minkowski space referred to Cartesian coordinates, and solutions to the vacuum Einstein equations are obtained. Several of these solutions are shown to be of Petrov type II null, and hence can be interpreted as gravitational waves. (Diss. Abstr. Int., B)

13802 COVARIANT GREEN FUNCTIONS OF THE PHOTON AND ELECTRON IN WEAK GRAVITATIONAL FIELDS. Carver, J. R. (City Coll., New York). Ann. Phys. (N. Y.); 68: No. 1, 244-80(Nov 1971).

By adapting the proper-time method to both the electromagnetic and Dirac fields in interaction with a weak vierbein field, bein gauge is treated on an equal footing with coordinate gauge. The calculations of the local one-photon as well as the second- and first-order-differential one-electron Green functions are developed in terms of the first-order vierbein and auxiliary fields and the weak-field potentials, and are shown to exhibit manifest coordinate- and bein-gauge covariance. The gauge separations of the first-order fields allow the isolation and evaluation of the contributions from both the coordinate- and bein-gauge functions, permit expressions of the first-order contributions to the Green functions in terms of the gauge-invariant weak-field potentials, and lead to the modified versions of the Mandelstam–DeWitt path-dependent line integrals. (auth)

13803 TWO GRAVITY-WAVE DETECTORS: A COMPARISON. Rasband, S. N. (Louisiana State Univ., Baton Rouge); Pipes, P. B.; Hamilton, W. O.; Boughn, S. P. Phys. Rev. Lett.; 28: No. 4, 253-5(24 Jan 1972).

The sensitivity of a dumbbell gravity-wave antenna is compared with that for a cylindrical detector. It is concluded that a Weber cylindrical antenna is decidedly the more sensitive at mutually accessible frequencies, particularly if the detector is to operate at higher frequencies in addition to the fundamental. A dumbbell antenna does offer the possibility of sampling the very low-frequency end of the spectrum, which is inaccessible to cylinders. (auth)

13804 ASYMPTOTIC BEHAVIOR OF VACUUM SPACE-TIMES. Couch, W. E. (Univ. of Pittsburgh); Torrence, R. J. J. Math. Phys. (N. Y.); 13: No. 1, 69-73(Jan 1972).

Newman and Penrose have given conditions on the asymptotic form of the Weyl tensor in empty space-time that are sufficient to insure that the space-time is asymptotically flat at null infinity and has the peeling property. Considerably weaker conditions are given and shown to be sufficient for asymptotic flatness. Under the weaker conditions the asymptotic behavior of the Weyl tensor is more general than the case where the peeling property holds. The asymptotic dependence on a suitably defined radial coordinate is given for the basis null tetrad, the spin coefficients, and the tetrad components of the Weyl tensor. (auth)

13805 WEAKER VERSIONS OF ZEEMAN'S CONJECTURES ON TOPOLOGIES FOR MINKOWSKI SPACE. Nanda, S. (R. E. Coll., Orissa, India). J. Math. Phys. (N. Y.); 13: No. 1, 12-15(Jan 1972).

In previous work [Topology 6, 161 (1967)] Zeeman conjectured that (a) the finest topology on Minkowski space that induces the one-dimensional Euclidean topology on every timelike line and (b) the finest topology on Minkowski space that induces the three-dimensional Euclidean topology on every spacelike hyperplane have the same group of homeomorphisms G which is generated by the inhomogeneous Lorentz group and the dilatations. Two topologies on Minkowski space are dealt with which are weaker than those in (a) and (b), respectively, and have the property that they induce the one-dimensional and the three-dimensional Euclidean topology on timelike lines and spacelike hyperplanes, respectively. It is then shown that both topologies have G as their homeomorphism group. Thus, what is shown amounts to proving the weaker versions of Zeeman's conjectures. (auth)

13806 THEORY OF THE DETECTION OF SHORT BURSTS OF GRAVITATIONAL RADIATION. Gibbons, G. W.; Hawking, S. W. (Cambridge Univ., Eng.). Phys. Rev., D; 4: No. 8, 2191-7(15 Oct 1971).

It is argued that the short bursts of gravitational radiation which Weber reports most probably arise from the gravitational collapse of a body of stellar mass or the capture of one collapsed object by another. In both cases the bulk of the energy would be emitted in a burst lasting about a millisecond, during which the Riemann tensor would change sign from one to three times. The signal-to-noise problem for the detection of such bursts is discussed, and it is shown that by observing fluctuations in the phase or amplitude of the Brownian oscillations of a quadrupole antenna one can detect bursts which impart to the system an energy of a small fraction of kT. Applied to Weber's antenna, this method

could improve the sensitivity for reliable detection by a factor of about 12. However, by using an antenna of the same physical dimensions but with a much tighter electromechanical coupling, one could obtain an improvement by a factor of up to 250. The tighter coupling would also enable one to determine the time of arrival of the bursts to within a millisecond. Such time resolution would make it possible to verify that the radiation was propagating with the velocity of light and to determine the direction of the source. (auth)

13807 THEORY OF THE ANGULAR DEPENDENCE OF A GRAVITATIONAL RADIATION DETECTOR. Mehra, Anjani (Univ. of Wisconsin, Green Bay). Phys. Rev., D; 4: No. 8, 2566-9(15 Oct 1971).

The directivity pattern for a gravitational radiation detector is obtained. A system of three orthogonal detectors is considered and relationships between their responses and the direction of the source are studied. The results are used for analyzing the variation in detector response with the earth's rotation. (auth)

13808 STATIC MULTIPARTICLE SYSTEMS IN GENERAL RELATIVITY. Gautreau, R. (Newark Coll. of Engineering, N. J.); Hoffman, R. B.; Armenti, A. Jr. Nuovo Cim.; 7B: No. 1, 71-98(11 Jan 1972).

Exact static solutions to the field equations of general relativity that represent axially symmetric distributions of isolated bodies are developed. The solutions obtained do not involve negative mass; the gravitational attraction between the bodies is counterbalanced by the Coulomb repulsion of electrical charges placed on the bodies. Since the assignment of physical interpretations to axially symmetric solutions is not straightforward in general relativity, additional arguments showing that the multiparticle interpretation is indeed correct are also presented. Thus we analyze, for the case of two isolated particles, the behavior of the differential invariants and the geodesic motion of test particles, and for all the examples considered agreement with the multiparticle interpretation is found. The solutions also contain nonsingular event horizons, which are related to an electrovac theorem recently proved by Israel. (auth)

13809 LINEARIZED MULTIPOLE EXPANSION OF THE GRAVITATIONAL-WAVE NEWS FUNCTION. Rotenberg, M. A. (Univ. of Wisconsin, Kenosha). Nuovo Cim.; 7B: No. 1, 99-109 (11 Jan 1972).

The Sachs news function, which is a generalized form of the Bondi news function and which mathematically controls the entire development of the gravitational waves from an isolated system, is calculated for a cohesive system in terms of the multiple-order moments of the material energy tensor T_{ik} for the source. A formula for the rate at which the source loses mass is then determined, and it turns out that this represents the rate of transmission of radiation energy from the source, as expected. (auth)

13810 SL_{2C} SYMMETRY OF THE GRAVITATIONAL FIELD. Carmeli, M. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Nuovo Cim.; 7A: No. 1, 9-20(1 Jan 1972).

The symmetry of the gravitational-field dynamical variables was previously discussed. A scheme was given according to which the spin coefficients and the Riemann tensor were represented in the form of linear combinations of the infinitesimal generators of the group SL_{2C}, similar to the way Yang and Mills write their dynamical variables in terms of the Pauli spin matrices, where the spin coefficients take the role of the Yang–Mills-like potentials and the Riemann tensor takes the role of the fields. This representation of the gravitational-field dynamical variables is used in order to write the field equations of general relativity, and a simple and attractive representation for the field equations of Newman and Penrose is obtained. Comparison between the present method and that of Utiyama, based on the Yang–Mills theory, is discussed and the possibility of using it as a basis for quantization is briefly mentioned. (auth)

13811 COMBINED NEUTRINO-GRAVITATIONAL FIELDS IN GENERAL RELATIVITY. Trim, D.; Wainwright, J. (Univ. of Waterloo, Ont.). J. Math. Phys. (N. Y.); 12: No. 12, 2494-8(Dec 1971).

The combined gravitational-neutrino field equations are solved, subject only to the restriction that the energy-flow vector of the neutrino field be timelike or null. The principal null congruence (pnc) of the neutrino field is necessarily geodesic and shearfree, and coincides with a repeated pnc of the gravitational field, which is thus algebraically special. The twist of the neutrino pnc plays an important role, and is zero if and only if the neutrino energy-flow vector is null, in which case the neutrino field represents pure radiation. (auth)

13812 DERIVATION OF EINSTEIN'S FIELD EQUATIONS. Chandrasekhar, S. (Univ. of Chicago). Amer. J. Phys.; 40: No. 2, 224-34(Feb 1972).

An attempt is made to clarify the physical and the mathematical reasonings that underlie Einstein's laws of gravitation. It appears that only by a mixture of physical reasonableness, mathematical simplicity, and aesthetic sensibility can one arrive at Einstein's field equations. The general theory of relativity is in fact an example of "the power of speculative thought." The topics considered include a discussion of the principle of equivalence and the view of space-time as a geometric manifold. Two "derivations" of Einstein's equations are given: one based on physical reasonableness and the other based on a variational principle and mathematical simplicity. (auth)

13813 ELECTROMAGNETIC RADIATION IN CURVED SPACES. Sigal, Richard (Yeshiva Univ., New York). J. Math. Phys. (N. Y.); 12: No. 12, 2490-4(Dec 1971).

The classes of trajectories of charged particles, for which the radiation reaction force vanishes, in curved spaces are examined. The trajectories in the Robertson–Walker cosmologies are given in detail and it is shown that the only reaction-free geodesic trajectories are those at rest relative to the local matter density. (auth)

13814 EXACT SOLUTION OF THE Γ EQUATION. Novello, Mario (Univ., Geneva). Helv. Phys. Acta; 44: No. 6, 697-702 (1 Oct 1971).

An attempt is made to evaluate a solution of the Γ equation with spherical symmetry and statical condition. One arrives at Schwarzschild's solution, as it would be expected. Some comments about the possibility of obtaining other solutions are made. (auth)

13815 GENERAL RELATIVITY AND KINETIC THEORY. Ehlers, J. (Univ. of Texas, Austin). Rend. Scu. Int. Fis. Enrico Fermi; 47: 1-70(1971).

The general-relativistic kinetic theory of gases is presented in a coherent and rigorous way. A summary of the Einstein theory of gravitation and its mathematical apparatus, differential forms and integration on manifolds, and kinetic theory are considered. (J.F.P.)

13816 SPACE–TIME STRUCTURE FROM A GLOBAL VIEWPOINT. Geroch, R. (Birbeck Coll., London). Rend. Scu. Int. Fis. Enrico Fermi; 47: 71-103(1971).

The availability and use of global techniques are indicated in general terms. A complete survey of the constructions and counter examples used in global work and some of the more important applications are included. Topology and manifolds, direction fields and orientation, the domains of influence and dependence in casual structure, and asymptotic properties are covered. (J.F.P.)

13817 DETECTION OF GRAVITATIONAL WAVES. Bertotti, B. (European Space Research Inst., Frascati, Italy). Rend. Scu. Int. Fis. Enrico Fermi; 47: 347-55(1971).

The cosmological aspects of the problem of detection of gravitational waves are reviewed. A description of gravitational waves, the gravitational wave spectrum, measurement of the curvature tensor using material test bodies, the effect of a gravitational wave on the intensity of a very distant source, and the order of magnitude of the second-order effect produced by the Weyl conformal curvature tensor are discussed. (J.F.P.)

13818 CREATION OF PARTICLES BY GRAVITATIONAL FIELDS. Urbantke, H. (Univ., Vienna). Rend. Scu. Int. Fis. Enrico Fermi; 47: 383-7(1971).

The discussion starts from the action principle. Some amount of matter already present, described by an energy–momentum tensor which generates a certain gravitational field, is separated. The effect of this g-field on some quantized matter field is studied and it is determined whether particles of this field are created and at what rate. A description of the early universe is given in which the particles emerge from an originally empty universe being created by their own gravitational field. (J.F.P.)

13819 CROSS EXPERIMENTS IN THE GENERAL RELATIVITY THEORY AND THE EXPERIMENTAL DETERMINATION OF THE RIEMANN CURVATURE TENSOR. Treder, H.-J. (Zentralinstitut fuer Astrophysik, Potsdam, Ger.). Monatsber. Deut. Akad. Wiss. Berlin; 13: No. 4-5, 310-17(1971). (In German).

If a laboratory with its total contents is moving free in the gravitational field, a gravitational effect is not locally establishable. The conditions for experiments in such a laboratory are derived. (J.S.R).

13820 GUIDED GRAVITATIONAL WAVES. Campbell, W. B.; Morgan, T. A. (Univ. of Nebraska, Lincoln). Nature (London) Phys. Sci.; 234: No. 51, 143-5(20 Dec 1971).

It is shown that, by analogy with certain solutions of Maxwell's equations, guided gravitational waves are a possibility. (auth)

Scattering Theory

Refer also to abstracts 13727, 13767, 13787, and 14208.

13821 (JINR–P2-6134) CONTINUAL SOLUTION OF THE QUASIPOTENTIAL EQUATION. Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

The solution of the quasipotential equation is obtained in the form of the Feynman continual integral over the phase-space paths, for which a method of finite approximation is suggested. (auth)

13822 (NP–19144) RESTRICTED THREE-BODY PROBLEM. Zehnder, Eduard (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 1970. 129p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis.

The didactic repetition of the Moser discussion of the stability behavior of the Poincare orbit of the first sort in the restricted three-body problem begins with the representation of a basic law on the canonical representation of a circular ring. This law is applied to the Poincare representation of transverse sections in the restricted three-body problem. This mechanical system is in the vicinity of an integrable system, the Kepler system. The altmodic angle and action variables were applied to the topology of this unperturbed system. The stability behavior of the Poincare orbit of the second type, which is in the vicinity of the circular orbit, was studied. (J.S.R.)

13823 OPTIMAL EQUATIONS FOR THREE-PARTICLE SCATTERING. Osborn, T. A.; Kowalski, K. L. (Stanford Univ., Calif.). Ann. Phys. (N. Y.); 68: No. 2, 361-76(Dec 1971).

Two differing approaches to the three-body scattering problem — that of Faddeev and Lovelace — are investigated. A simple operator connection is found between the two methods and this connection is used to give a physical justification of Faddeev's residue prescription for determining those three-body scattering amplitudes in which a two-particle bound state is in the initial and/or final configuration. Based on these results, derivations of a class of integral equations for simple and natural half-off shell extensions of the breakup and rearrangement amplitudes are presented. (auth)

13824 MULTIPLE SCATTERING IN GLAUBER THEORY. Fanchiotti, H.; Osborn, T. A. (Oxford Univ.). Nucl. Phys.; A177: No. 1, 273-88(1971).

In a model problem composed of two overlapping Yukawa potentials Glauber's multiple diffraction scattering approximation for scattering from a fixed composite system is studied. By contrasting the predictions obtained from the impulse approximation, the impulse plus double scattering approximation, the Glauber approximation and the exact solution, it is concluded that cancellations in the multiple scattering series are responsible for the accuracy of the Glauber method. The eikonal representation, the Blankenbecler–Goldberger representation, and a unitarized impulse approximation are also studied. (auth)

13825 REGGEON GRAPH SCHEME AT AVAILABLE, NOT ULTRA-HIGH, ENERGIES. Ter-Martirosyan, K. A. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys.; B36: No. 2, 566-74(1972).

A consistent theory, based on Gribov's Reggeon graph technique, has been developed which takes account of Regge poles and all cuts connected with combinations of several poles. This approach is extended to presently available energies. (auth)

13826 NEW CLASS OF DUAL VERTICES. Clavelli, L.; Ramond, P. (National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 4: No. 10, 3098-3101(15 Nov 1971).

A new SU(1,1) coupling scheme, based on the discrete class representations, is proposed to construct factorizable dual amplitudes. Dual vertices for off-shell particles of even spin are introduced and other applications of the method are discussed. The analysis suggests the nonexistence of a dual vector current within the context of the conventional Veneziano model. (auth)

13827 TRIPLE-REGGE COUPLING AND DIFFRACTIVE SPIN DEPENDENCE. Chang, Shau-jin; Gordon, Daivd; Low, F. E.; Treiman, S. B. (National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 4: No. 10, 3055-61(15 Nov 1971).

From qualitative arguments based on Regge behavior of three-to-three scattering amplitudes, taken together with the assumption that the vacuum trajectory function passes through unity and has a finite slope there, it is argued that (1) the vertex function coupling three vacuum trajectories vanishes linearly at zero momentum transfer, and (2) a certain constraint equation equivalent to the vanishing of a single crossed-channel helicity amplitude connects the $j + 1$ independent helicity amplitudes for forward diffractive scattering of a boson of spin $j \geq 1$. The appearance of certain spurious poles in the $3 \rightarrow 3$ amplitude plays an important role in the discussion. The arguments are checked in a simple Feynman–diagram model. (auth)

13828 IMPACT-PARAMETER REPRESENTATION FOR ALL SCATTERING ANGLES. Berlad, G. (Technion-Israel Inst. of Tech., Haifa). Nuovo Cim.; 6A: No. 4, 594-600(21 Dec 1971).

An impact-parameter representation of the potential scattering amplitude, valid over the whole range of scattering angles is derived. Its high-energy limit is then investigated for a potential which depends linearly on the c.m. momentum. The convergence of the general formula to the usual Glauber expression at vanishing scattering angles is demonstrated, and a method for deriving finite-energy corrections to the scattering amplitude is presented. (auth)

13829 PERTURBATION OF A CONTINUOUS SPECTRUM BY A NEAR-LYING LEVEL. Perelomov, A. M.; Popov, V. S. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 5, 1743-55(Nov 1971). (In Russian).

The nature of the perturbation of continuous spectrum functions $\chi_k(r)$ and the analytic properties of the S matrix in the region $k \rightarrow 0$ in the presence of a level close to zero are considered. Formulas are obtained which express parameters of the low energy expansion of the S matrix in terms of the wave function $\chi_0(r)$ at the moment of formation of the level. Exact solutions of the problem are obtained for a number of potentials. (auth)

13830 JOST FUNCTION OF A MOMENTUM-DEPENDENT POTENTIAL. Warke, Chindhu S. (McMaster Univ., Hamilton, Ont.). J. Math. Phys. (N. Y.); 13: No. 1, 1-3(Jan 1972).

It is proved that the Jost function of a central, momentum-dependent, S-state interaction is equal to the ratio of the Fredholm determinant of the kernel of the integral equation for the outgoing scattering solution in the momentum space representation to that of the regular solution in the same representation. This proof of the expected result is more general than that given by Warke and Bhaduri for a non-local interaction. (auth)

13831 DIFFERENTIAL EQUATION FOR THE FEYNMAN INTEGRAL CORRESPONDING TO ONE-LOOP DIAGRAM. Golubeva, V. A. Teor. Mat. Fiz.; 9: No. 3, 380-7(Dec 1971). (In Russian).

The Feynman integral I(s,t) for one loop diagram with four vertices is considered. With the aid of the Griffiths' method of differentiating rational differential forms with respect to the parameter, it is proved that I(s,t) satisfies the system of two first order differential equations. From this system a hyperbolic partial differential equation for I(s,t) is obtained, the main coefficient of which vanishes on the Landau's manifold of the Feynman integral. (auth)

13832 EIKONALIZATION OF SCATTERING AMPLITUDE IN SOME FIELD THEORY MODELS AT HIGH ENERGY. Barbashov, B. M.; Nesterenko, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 9: No. 3, 343-54 (Dec 1971). (In Russian).

The high-energy scattering of particles in some field theory models and the possibility of representing the scattering amplitude in the eikonal form are studied. (auth)

13833 FEW-BODY PROBLEM FORMALISM. Azziz, N. (Univ. of Uruguay, Montevideo). Nuovo Cim.; 7A: No. 1, 60-70(1 Jan 1972).

A formalism is presented to solve the coupled equations for three- or a few-particle problem. This is developed in Section 2, however, for completeness and also with the hope that it may give some new view to the reader, Section 1 is devoted to deducing formally those coupled equations. In Section 3 the two-body system when the other particles are present is solved. (auth)

13834 ROLE OF FIXED ANGULAR-MOMENTUM-PLANE BRANCH POINTS, WITH REGARD TO THE $t = 0$ SINGULARITY STRUCTURE OF REGGEIZED SCATTERING AMPLITUDES. II. Jenkins, J. D. (Univ. of Kent, Canterbury, Eng.). Nuovo Cim; 7A: No. 1, 153-62(1 Jan 1972).

The Van Hove model is used to construct a Regge amplitude for the scattering of spinless particles, which only involves contributions from a Regge pole, a fixed branch point and the background integral. Under certain circumstances, the fixed-branch-point contribution cancels infinites which appear in the background integral and Regge-pole terms at $t = 0$. The latter cancellation is demonstrated explicitly for a linearly rising trajectory. (auth)

13835 KINEMATICAL SINGULARITIES AND CONSTRAINTS OF HELICITY AMPLITUDES FOR FIVE-PARTICLE PROCESSES. Navelet, H. (CERN, Geneva); Pittet, E. Nuovo Cim.; 7A: No. 1, 185-225(1 Jan 1972).

Raynal's method of getting the kinematical singularities of the helicity amplitudes is extended to the five-particle processes involving massive particles of any spin. This procedure allows regularized helicity amplitudes to be constructed. Constraints between these amplitudes are explicitly derived. (auth)

13836 ANALYTICITY PROPERTIES OF HELICITY AMPLITUDES FOR FIVE-BODY PROCESSES INVOLVING MASSLESS PARTICLES. Navelet, H. (CERN, Geneva); Pittet, E. Nuovo Cim.; 7A: No. 1, 226-41(1 Jan 1972).

Taking into account gauge conditions, results previously obtained for five massive particles are extended to the massless case by using Raynal's method. This procedure allowed in the massless case regularized helicity amplitudes to be built, the constraints of which have been explicitly derived. (auth)

13837 CONTINUITY EQUATIONS FOR MANY-BODY SYSTEMS. Rivier, N.; Pelka, D. G. (Univ. of California, Riverside). Nuovo Cim.; 7B: No. 1, 1-16(11 Jan 1972).

The four-divergence of a generalized current is related to the Green's function formulation of the many-body problem. The relations obtained take the form of continuity equations, with an extra source term corresponding to the creation or annihilation of particles allowed by the second-quantization formalism. With the aid of these many-body continuity equations, a connection between the two types of conservation laws for Green's function in the literature, the generalized Ward identity and the conserving approximations of Baym and Kadanoff is derived. (auth)

13838 PHASE SHIFT. II. AS A CONTINUOUS FUNCTIONAL. Frank, William M.; McLaughlin, David W. (Naval Ordnance Lab., Silver Spring, Md.). J. Math. Phys. (N. Y.); 12: No. 12, 2525-9(Dec 1971).

The continuity of the phase shift and S-wave scattering length as a functional of the potential is considered. The question is investigated for sequences of square wells which converge pointwise to zero. The results show certain conditions to be sufficient for convergence of the phase shift and scattering length to zero. These results are generalized to certain integral norms. (auth)

13839 PHASE SHIFT. III. AS A CONTINUOUS FUNCTIONAL. Frank, William M. (Naval Ordnance Lab., Silver Spring, Md.). J. Math. Phys. (N. Y.); 12: No. 12, 2529-37 (Dec 1971).

The continuity of the phase shift and scattering length as a functional of the potential is considered. It is found that the convergence of $\int dr|V_n|$ to zero is a sufficient though not necessary condition for the vanishing of the phase shift, while the convergence of $\int dr\, r|V_n(r)|$ or $\int dr|V_n(r)|^{\frac{1}{2}}$ to zero would be a sharp condition. A number of theorems of this type are proven. Theorems are also proven demonstrating the continuity of the phase shift and scattering length as a sequence of potentials converging in the proper norms to a non zero potential. Some implications of the existence of a Banach space of potentials are discussed briefly. (auth)

Particle Accelerators

Refer also to abstracts 11836, 11837, 12142, 12146, 12150, 12151, 12153, 12154, 12399, 13492, 13494, 13507, 13533, 13534, 13758, and 14095.

13840 (CONF-710402-(Vol.1), pp I.19-27) ACCELERATORS UTILIZED IN NEUTRON APPLICATIONS. Morgan, Ira Lon (Texas Univ., Austin. Center for Nuclear Studies). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The one thousand accelerators located in the United States are utilized to some extent for the production of neutrons. In basic research or applied neutron physics the characteristics of the accelerator have primarily determined the yield and energy distribution of the neutron source. Wide and diverse applications of neutron fields to the study of various problems are presented. A satisfactory solution of problems in neutron applications requires the designs of accelerators whose intensity and energy distribution will produce the proper neutron field. Accelerators are discussed with respect to types, intensities, and distribution of neutron fields, which they provide. The increasing demand for high intensity neutron fields has created a progression of accelerator developments over the past forty years. Neutron yields in the order of 10^{14} to 10^{9} n/sec may now be considered possible. Problems associated with producing the desired neutron field are presented. (auth)

13841 (CONF-711012-15) KYUSHU UNIVERSITY POLARIZED ION SOURCE. Sonoda, M.; Wakuta, Y.; Hasuyama, H.; Tsuji, K.; (Kyushu Univ., Fukuoka (Japan). Dept. of Nuclear Engineering). [1971]. 4p. Dep. NTIS (U. S. Sales Only).

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

A source of polarized deuterons and protons using an atomic beam method is described. This conventional source is equipped with radiofrequency transition region and a strong field ionizer to increase the polarization of the beam. The tensor polarization of deuterons was obtained by analyzing the anisotropy in the angular distribution of emitted neutrons from the $T(d,n)^4He$ reaction. The polarization obtained is, typically, $P_{33} = 1/3$ and the polarized beam intensity is about 1 nA at the target. (auth)

13842 (JINR-P2-6056) TRANSPORTING OF THE HIGH-ENERGY PARTICLE BEAMS THROUGH THE THICK SLABS OF THE MATTER. Barashenkov, V. S.; Sobolevskii, N. M.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The absolute yield, spectral angular characteristics and spatial distribution for particles behind a thick shield are calculated by the Monte-Carlo method. The cascade-evaporation model is used to describe particle-nucleus interactions. The comparison between theory and experiment shows that the method developed can successfully be employed in the calculation of radiation shielding. This method is applicable at primary energies up to a few dozens of GeV. (auth)

13843 (LBL-500) PROCEEDINGS OF THE 2nd INTERNATIONAL CONFERENCE ON POLARIZED TARGETS, 30 AUGUST-2 SEPTEMBER 1971, BERKELEY, CALIFORNIA. Shapiro, Gilbert (ed.) (California Univ., Berkeley. Lawrence Berkeley Lab.). 421p. (CONF-710815). Dep. NTIS.

Separate abstracts were prepared for 55 of the 57 papers presented. Two papers were previously included in NSA. (W.H.K.)

For abstracts of individual papers see: 13126, 13489, 13513, 13514, 13531-13533, 13630, 13723, 13748, 13844-13878, 13940, 13959, 14006, 14007, 14087-14090, 14197, and 14198.

13844 (LBL-500, pp 1-32) MECHANISMS OF NUCLEAR DYNAMIC POLARIZATION BY ELECTRON-NUCLEUS DIPOLAR COUPLING IN SOLIDS. Borghini, M. (European Organization for Nuclear Research, Geneva (Switzerland)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Various mechanisms occurring in the dynamic orientation of nuclear spins in solids are compared together and compared with experiment, especially with the results obtained in those substances which are used as polarized targets. (auth)

13845 (LBL-500, pp 33-41) DYNAMIC NUCLEAR POLARIZATION AND ELECTRONIC SPIN-SPIN INTERACTIONS. Morimoto, K. (Tokyo Univ. (Japan). Dept. of Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The dynamic polarization of protons was observed in polystyrene at three different temperatures. A phenomenological theory is developed. It is pointed out that cross relaxation due to the electronic spin-spin interactions is important, when the ESR line is inhomogeneously broadened. The solid effect is dominant at higher temperatures, but it is almost completely quenched and the cross effect gives the large nuclear polarization at low temperatures. (auth)

13846 (LBL-500, pp 43-6) SOLID EFFECT WITH AN INHOMOGENEOUSLY BROADENED ESR LINE. Wollan, David S. (Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The theory for the solid effect in the case of a completely inhomogeneously broadened ESR line with unresolved satellites is considered. By including spin diffusion among the nuclei, one finds that dynamic nuclear polarization enhancements greater than 0.5 of the ideal enhancement are possible in favorable cases. Experimental results in rough agreement with theory are presented. (auth)

13847 (LBL-500, pp 47-55) PROGRESS IN POLARIZED TARGET CRYOGENICS. Roubeau, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

A big improvement in free-to-bound proton ratio while keeping polarization in the 70 to 80% range has been obtained by using glycol or butanol targets cooled at 0.5 K. New cryostats incorporating a separate He 3 circuit are described which allow large thermal dissipation at this temperature. (auth)

13848 (LBL–500, pp 57-68) SUPERCONDUCTING MAGNETS FOR POLARIZED TARGETS. Desportes, H. (Argonne National Lab., Ill.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The advantages of superconducting magnets for polarized target experiments and the large variety of possibilities they offer in this application are reviewed. Existing operating systems are described as well as new projects and future ideas. (auth)

13849 (LBL–500, pp 69-71) ^{3}He-COOLED POLARIZED TARGETS. Vermeulen, J. (European Organization for Nuclear Research, Geneva (Switzerland)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

A new cryostat for polarized targets has been built and brought into service. This target features a cavity which is 150 mm long with a volume of 47 cm^3. The butanol sample was cooled down to 0.55°K and polarized to 60%. The particle beam enters longitudinally through the cryostat. Two built-in scintillator counters are placed at low temperature, close to the target, to define the incoming particle beam. The use of a Joule-Thomson heat exchanger in the ^{3}He system avoids the otherwise necessary large ^{4}He pumping system for the precooler. (auth)

13850 (LBL–500, pp 73-5) POSSIBLE POLARIZED ^{3}He TARGETS USING THE ADIABATIC COMPRESSION METHOD. Wheatley, John C. (California Univ., La Jolla, San Diego. Dept. of Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The basic method of adiabatic compressional cooling of helium-3 is briefly discussed, and comments related to the characteristics of a possible polarized target are presented. (W.H.K.)

13851 (LBL–500, pp 77-83) COMPRESSED POLARIZED HELIUM THREE GAS. Daniels, J. M. (Toronto Univ. (Ontario)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Two experiments have demonstrated that polarized ^{3}He remains polarized when it is compressed. One of these experiments is described in detail. Results are given of measurements of the relaxation of the polarization of ^{3}He on various solid surfaces; materials are available in which polarized ^{3}He may be contained for periods of the order of days. A design for a compressed polarized ^{3}He target is mentioned. Results of calculations and measurements of the rate of polarization of ^{3}He are presented. (auth)

13852 (LBL–500, pp 85-8) NUCLEAR PHYSICS EXPERIMENTS WITH POLARIZED ^{3}He TARGETS. Baker, Stephen D. (Rice Univ., Houston, Tex.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

A brief summary of scattering experiments with polarized ^{3}He targets is given, several possible future experiments are suggested, and some remarks on spin relaxation due to ionizing radiation in high pressure polarized ^{3}He gas are made. (auth)

13853 (LBL–500, pp 89-98) PRESENT AND FUTURE PROSPECTS FOR SEPARATED FUNCTION FROZEN TARGETS. Russell, F. M. (Rutherford High Energy Lab., Chilton (England)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

To obtain unusually large angular access to a polarized target the material is first polarized under favorable conditions, cooled to slow down relaxation rates and then transferred to a region favorable for particle scattering experiments. Hence the functions of polarization and data collection are separated. A prototype for use in a $\pi^-p \to \pi^0n$ and $\pi^-p \to \eta^0n$ experiment is described. Access of nearly 3π steradian can be achieved but with reduced polarization. By using two targets in one enclosure the performance of a separated function target can be made superior to a conventional, continuously polarized target. Possible application of these ideas to a large volume (3000 cm^3) polarized target is described. (auth)

13854 (LBL–500, pp 99-102) TOWARD POLARIZED SOLID HD. Honig, A. (Syracuse Univ., N. Y.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The properties of solid polarized HD, in which the polarizations of the proton and/or deuteron are metastably frozen-in at ordinary liquid ^{4}He temperatures, are discussed. Recent experimental results bearing on the feasibility of the system are presented, with particular emphasis on the relaxation properties of proton and deuteron, and the J = 1 to J = 0 conversion (ortho–para for H_2 and para–ortho for D_2), on which the success of the method largely depend. (auth)

13855 (LBL–500, pp 103-6) PROTON RESONANCE IN SOLID H–D AT VERY LOW TEMPERATURES. Bozler, H. M.; Graf, E. H. (State Univ. of New York, Stony Brook). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Proton spin-lattice relaxation times (T_1) and polarization in solid hydrogen deuteride have been studied in a magnetic field of ~14 kgauss by ~60 MHz CW nuclear resonance techniques, at temperatures as low as 40 m°K. The nuclear spin susceptibility is found to obey a Curie law and T_1 varies as a weak exponential of 1/T in the temperature range $0.040°K < T < 0.2°K$. The effects of ortho-para conversion of H_2 impurities on T_1 are studied and values of T_1 as long as 2×10^4 sec are observed at the lowest temperatures. Comparisons with other workers are made and plans and prospects for statically polarized H-D targets are discussed. (auth)

13856 (LBL–500, pp 107-12) POWERFUL HORIZONTAL DILUTION REFRIGERATOR WITH POSSIBLE APPLICATIONS IN DYNAMIC POLARIZATION, SPIN FREEZING, AND BRUTE FORCE POLARIZATION. Niinikoski, T. O. (European Organization for Nuclear Research, Geneva (Switzerland). Helsinki Univ. of Technology, Otaniemi (Finland). Dept. of Technical Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The construction and performance of a powerful dilution refrigerator are described. The use of a dilution refrigerator in dynamic polarization, spin freezing, and brute force polarization of protons are briefly discussed. (auth)

13857 (LBL–500, pp 113-16) T_1 MEASUREMENTS FOR PROTONS IN 1,8-OCTANEDIOL AND BUTANOL AT ULTRA-LOW TEMPERATURES. Niinikoski, T. O. (European Organization for Nuclear Research, Geneva (Switzerland). Helsinki Univ. of Technology, Otaniemi (Finland). Dept. of Technical Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Relaxation time measurements show that 1,8-octanediol, which is solid at room temperature, would be a good candidate for a "frozen spin" target at temperatures obtainable with dilution refrigerators. Relaxation times of the order of one month were measured in 1,8-octanediol doped with Cr(V)-glycol complexes, at 15 and 25 kOe field and about 54 mK temperature. The butanol sample contained about 0.59% porphyrexide in 95:5 1-butanol: water resulting in longer relaxation times than those measured in normal butanol targets containing 1% porphyrexide.

13858 (LBL–500, pp 205-8) EXPERIENCE WITH A POLARIZED PROTON TARGET AT THE BONN 2.5 GeV SYNCHROTRON. Althoff, K. H.; Herr, H.; Hoffmann, W.; Kadansky, V.; Schittko, F. J. (Bonn Univ. (West Germany). Institut fuer Physikalische Chemie). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

A polarized butanol target has been built to study photoproduction reactions on polarized protons at the Bonn 2.5 GeV Electron Synchrotron. Some details of the target construction and the behavior of the target material in the external photon beam are described. (auth)

13859 (LBL–500, pp 209-12) SPECIAL PROBLEMS IN USING POLARIZED TARGETS AT ELECTRON ACCELERATORS. Chen, J. R. (Pennsylvania Univ., Philadelphia. Dept. of Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The problems encountered in using polarized targets at electron accelerators are discussed by comparing beam and microwave heating, radiation damage, and radiative corrections for electrons and muons. (auth)

13860 (LBL–500, pp 213-15) POLARISED TARGET ASYMMETRY FOR PI-ZERO PHOTOPRODUCTION AT 4 GeV. Booth, P. S. L.; Boyes, E.; Court, G. R.; Craven, B.; Gamet, R.; Hayman, P. J.; Holt, J. R.; Hufton, A. P.; Jackson, J. N.; Norem, J. H. (Liverpool Univ. (England)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Preliminary measurements have been made of the polarized target asymmetry for pi-zero photoproduction at 4 GeV. Data are presented for five values of four-momentum transfer squared in the range 0.25 to 1.05 (GeV/c).^{2} (auth)

13861 (LBL–500, pp 223-34) STATIC ORIENTATION METHODS AND EXPERIMENTS WITH ORIENTED RADIOACTIVE NUCLEI. Shirley, D. A. (California Univ., Berkeley. Lawrence Berkeley Lab.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

"Static," or thermal-equilibrium, methods for orienting nuclei are reviewed. Examples are cited to illustrate applications to the study of symmetry properties and to solid state studies. Resonance and relaxation experiments are discussed. (auth)

13862 (LBL–500, pp 247-55) CLEAN EXAMPLE OF LARGE DYNAMIC POLARIZATION OF ^{19}F IN CaF_2. Abragam, A.; Chapellier, M.; Goldman, M.; Jacquinot, J. F.; Chau, Vu Hoang (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Large nuclear polarizations (up to 90%) of ^{19}F have been obtained in CaF_2 doped with paramagnetic ions (U^{3+} and Tm^{2+}) by the solid effect method. Various aspects of the polarization process including evidence of strong phonon bottleneck are described. A new method is presented for the measurement of absolute values of large nuclear polarizations. (auth)

13863 (LBL–500, pp 259-61) LOW-TEMPERATURE POLARIZATION OF Bi ISOTOPES IN FERROMAGNETIC BiMn AND POLARIZED ^{209}Bi TARGET. Nagamine, K.; Nishida, N.; Yamazaki, T. (Tokyo Univ. (Japan). Dept. of Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

A low temperature nuclear orientation study was made on $^{205,206}Bi$ in ferromagnetic BiMn compound and a large hyperfine field on the Bi nucleus (around 800 kOe) was observed. This leads to a polarized ^{209}Bi target in the temperature range below 0.1 K. (auth)

13864 (LBL–500, pp 271-9) DYNAMIC POLARIZATION OF DEUTERONS IN n-BUTANOL-(D_{10}) AND PROTONS IN AMMONIA. Scheffler, K. (European Organization for Nuclear Research, Geneva (Switzerland)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Some results of studies on the dynamic polarization of deuterons in n-butanol-(D_{10}), doped with the free radical porphyrexide, and proton polarization in liquefied ammonia doped with paramagnetic Cr(V) complexes are presented and discussed. (W.H.K.)

13865 (LBL–500, pp 281-7) ORGANIC MATERIALS FOR POLARIZED PROTON TARGETS. Glaettli, Hans (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Some of the properties and performances of the currently used organic target materials are reviewed and compared, with the emphasis on the butanol-water-porphyrexide and ethylene-glycol-Cr(V) system. The chemical processes are described which lead to the Cr(V) complex often used as paramagnetic impurity. Polarizations comparable to those obtained in glycol are reported in pinacone-Cr(V), a substance which is solid at room temperature. (auth)

13866 (LBL–500, pp 289-94) PROTON POLARIZATION IN ALCOHOLS AT 50 KG, 1° K. Hartmann, G.; Hubert, D.; Mango, S.; Morehouse, C. C.; Plog, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Proton polarizations $P_n \sim 80\%$, polarization build-up times $\tau_p \sim 2$ min and relaxation times $T_n \sim 40$ min have been repeatedly obtained at 1°K and 50 kG in 1-butanol- and 1-pentanol-water mixtures doped with porphyrexide. Shorter (or longer) T_n's and τ_n's can be obtained by varying the target composition, when accepting a certain loss in polarization. (auth)

13867 (LBL–500, pp 295-9) ON THE POSSIBILITIES OF DEVELOPMENT OF POLARIZED TARGETS. Masaike, Akira (Nagoya Univ. (Japan)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The possibilities of the dynamic polarization at a temperature lower than 0.5°K and a comparison of the usefulness of 50 kG, 1°K and 25 kG, 0.5°K for the polarized target are discussed. (auth)

13868 (LBL–500, pp 301-2) DYNAMIC PROTON POLARIZATION IN 1,8-OCTANEDIOL-GLYCOL MIXTURES. Weymuth, P. (European Organization for Nuclear Research, Geneva (Switzerland)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Protons have been polarized up to 30% at 1 K and up to 60% at 0.5 K in a 25 kOe field in 1,8-octanediol samples doped with Cr(V)-glycol complexes. These samples are solid at room temperature. (auth)

13869 (LBL–500, pp 303-4) DYNAMIC POLARIZATION OF ^{13}C IN 1-BUTANOL. Borghini, M.; Scheffler, K. (European Organization for Nuclear Research, Geneva (Switzerland)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Polarization of 18% has been achieved for ^{13}C nuclei at 0.5 K and 25 kG in 1-butanol doped with porphyrexide. (auth)

13870 (LBL–500, pp 305) POLARIZATION IN ASSORTED HYDROCARBONS. Gorn, W.; Robrish, P. (California Univ., Berkeley. Lawrence Berkeley Lab.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The proton polarizations that have been achieved in various hydrocarbons at 1°K and 25 kOe are listed. A 50% polarization was achieved in 1,2-propanediol with Cr(V) doping. (auth)

13871 (LBL–500, pp 367-9) CALIBRATION OF POLARIZED TARGETS WITH POLARIZED PROTON AND DEUTERON BEAMS. Ohlsen, Gerald G.; Keaton, P. W. Jr. (Los Alamos Scientific Lab., N. Mex.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Methods for using a beam of protons or deuterons with known polarization to calibrate certain polarized targets are discussed. The concepts are applicable, in principle, at any energy, and are based on the simple spin structure of certain reactions. Application to ^3He, ^{19}F, and ^{15}N targets is discussed. (auth)

13872 (LBL–500, pp 381-90) NUCLEAR POLARIZATION BY OPTICAL PUMPING IN SOLIDS. Jeffries, C. D. (California Univ., Berkeley). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Some methods of polarizing nuclei in solids by optical pumping are discussed, and experimental results from Berkeley are presented. ^{169}Tm and ^{19}F are polarized in $Tm^{2+}:CaF_2$ by pumping with circular polarized light in a magnetic circular dichroism band. For the bulk protons in ytterbium, yttrium ethyl sulfate, J. P. Wolfe obtains a negative polarization leading to maser oscillations by a new method involving optically pumped localized molecular excitations. A sensitive NMR apparatus is used to observe directly for the first time the resonance, relaxation, and dynamic polarization behavior of specific protons near a paramagnetic ion. This is an important new experimental approach to the microscopic mechanisms for dynamic polarization and spin diffusion. (auth)

13873 (LBL–500, pp 391-5) MISCELLANEOUS THOUGHTS ABOUT MEASUREMENT OF POLARIZATION, TARGET UNIFORMITY, AND RADIATION DAMAGE. Shapiro, Gilbert (California Univ., Berkeley. Lawrence Berkeley Lab.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The problems involved in making accurate measurements of the target polarization are reviewed. It is concluded that the problems arising from the possible non-linearity of the NMR readout system are not as serious as the problems of calibration of the NMR signal and of the non-uniform distribution of target polarization. (auth)

13874 (LBL–500, pp 397-401) SOME NEW FEATURES IN A NUCLEAR MAGNETIC RESONANCE DETECTION SYSTEM FOR MEASURING POLARIZATION OF HIGHLY POLARIZED SUBSTANCES. Udo, F. (European Organization for Nuclear Research, Geneva (Switzerland)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Three propositions to improve the NMR, Q-meter technique for polarization measurement are described. (a) A better pick-up coil configuration is proposed. (b) It is shown that one can place the tuning capacitor inside the cryostat thus eliminating the $\frac{1}{2}\lambda$ cable. (c) The effects of the dispersive part of the NMR resonance can be displayed and corrected for by comparing the response of the Q-meter to that of an identical LC circuit phase locked to the Q-meter. Also, a calculation of linearity of the proposed system is presented. (auth)

13875 (LBL–500, pp 403-6) MEASUREMENTS OF THE EFFECT OF ABSORBED POWER ON THE POLARIZATION ATTAINABLE IN A BUTANOL TARGET. Boyes, E.; Court, G. R.; Craven, B.; Gamet, R.; Hayman, P. J. (Liverpool Univ. (England)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Measurements have been made of the polarization attainable at 1°K for the conventional polarized target material (frozen balls of butanol-water mixture), as a function of ball diameter, in the range 1 to 6 mm. Also for each ball diameter, the mean temperature difference between the helium bath and balls has been measured as a function of absorbed power using the relaxation time as a thermometer. The Kapitza resistance is found to be 59 ± 28 cm^2 deg $watts^{-1}$, and the thermal conductivity is found to be $2.1 \pm 1.1 \times 10^{-3}$ watts cm^{-1} deg^{-1}. Estimates are made of how absorbed power in the balls would limit the polarization attainable at 0.5°K. (auth)

13876 (LBL–500, pp 407-10) AN ON-LINE COMPUTER POLARISATION MEASURING SYSTEM USING R.F. PHASE LOCK TECHNIQUES. Boyes, E.; Court, G. R.; Craven, B. J.; Gamet, R.; Hayman, P. J. (Liverpool Univ. (England)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

A polarization measuring system has been constructed which avoids any dispersion corrections. This is done by deriving a reference R.F. voltage before applying the sampling R.F. voltage to a constant voltage Q-meter. When the two voltages are applied in phase to a double balanced demodulator the output contains only the absorptive phase of the signal. The polarization is calculated by conversion of the analogue D.C. to digital pulses which are read to CAMAC scalers, interfaced into a computer. Software is used to calculate the thermal equilibrium calibration and subsequent polarizations. (auth)

13877 (LBL–500, pp 411-12) PHYSICAL ARRANGEMENT FOR USE WITH LARGE VOLUME POLARIZED TARGETS. Chen, J. R. (Pennsylvania Univ., Philadelphia. Dept. of Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The advantages of a scheme containing both signs of the target polarization in a large volume polarized target are described. Dead-times caused by frequent reversals of the polarization in experiments measuring small asymmetries and systematic errors arising from fast (beam) fluctuations are greatly reduced. (auth)

13878 (LBL–500, pp 413-15) PROPOSAL FOR AN ACCURATE, NON-RESONANT MEANS TO MEASURE TARGET POLARIZATION. Wheatley, John C. (California Univ., La Jolla, San Diego. Dept. of Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

A method for measuring nuclear polarization by means of measurement of mechanical forces is discussed. Calculations for polarized helium-3 targets are included. (W.H.K.)

13879 (LYCEN–7149) MEASUREMENT OF THE ELECTROMAGNETIC FIELD IN AN INTERDIGITAL STRUCTURE. CONSEQUENCES FOR STUDY OF TOLERANCES AND DISTRIBUTION OF HF LOSSES. Foret, Francois (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1971. 57p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The problems related to the construction of the accelerating cavity of the heavy ion linear accelerator of Lyon (interdigital structure of H-type) were studied. The effect of the variation of different geometrical parameters on the distribution law of the accelerating field was analyzed, and the geometrical limits are deduced from this analysis. The currents in the drift tube supports and in the walls were studied. The electromagnetic field in some interesting regions of the device was measured in order to determine the maximum permissible electric field in an accelerating gap. The accelerating field is generally limited by breakdown phenomena, but for an interdigital H structure, cooling may be the limiting factor since the power dissipated in the support is very high. (France)

13880 (RHEL/R–226) A 500 kV MEDIUM GRADIENT PREINJECTOR. Wroe, H.; Fowler, R. G. (Rutherford High Energy Lab., Chilton (England)). Feb 1971. 10p. Dep. NTIS (U. S. Sales Only).

A medium gradient prototype preinjector for proton accelerators is described. The accelerating column consists of a short length of Van der Graaff tube supported inside an insulating tube; the space between the tubes is filled with sulphur hexafluoride gas. Pulsed proton beams of over 150 mA at 500 kV were produced. (UK)

13881 (TID–25874) 1970 SUMMER STUDY. (National Accelerator Lab., Batavia, Ill.). 433p. Dep. NTIS.

Forty-six separate abstracts were prepared for the papers in this report. (R.W.R.)

For abstracts of individual papers see: 12142–12154, 13490–13495, 13505–13509, 13517, 13534, 13585–13588, 13631, and 13882–13896.

13882 (TID–25874, pp 19-21) ARE POLARIZED PHOTON BEAMS FEASIBLE AT NAL? Patel, P. (McGill Univ., Montreal (Quebec)). 1970.

In 1970 summer study.

It is shown that the technique of coherent bremsstrahlung from crystals will not give polarized beams of useful intensities for counter and spark-chamber work. (auth)

13883 (TID–25874, pp 39-43) USE OF THE 3.5-MRAD BEAM FOR ELECTRONS. Morrison, R. J. (California Univ., Santa Barbara); Pretzl, K. P.; Read, A. L. 1970.

In 1970 summer study.

The high-intensity beam of Area 2 is considered for use as an electron beam. It is pointed out that the first septum magnet can be used for sweeping out the charged particles. The beam transport then starts with the second septum magnet which just follows the photon–electron converter. Expected beam intensities are given. (auth)

13884 (TID–25874, pp 115-56) POLARIZED TARGETS AT NAL. Berger, E.; Yokosawa, A. (Argonne National Lab., Ill.); Burleson, G.; Patel, P. M.; Pipkin, F. M.; Pretzl, K. P. 1970.

In 1970 summer study.

The conclusions of the group studying the use of polarized targets at NAL are summarized. The report discusses the reasons for interest in polarized targets, the experiments with polarized targets, and the recommended target for NAL. This target uses a 50-kG magnet and a temperature of 1°K. The target is 13 cm long and has a cross section which is 2.5 cm × 2.5 cm. The polarization would be 70%; and the reversal time, 3.5 minutes. (auth)

13885 (TID–25874, pp 157-60) RECOMMENDATIONS FOR LARGE-APERTURE, GENERAL-PURPOSE MAGNETS AT NAL. Jenkins, T. (Case-Western Reserve Univ., Cleveland, Ohio). 1970.

In 1970 summer study.

The magnet requirements of the first 79 proposals were studied. As a result, recommendations are made for the acquisition of magnets of three different designs. (auth)

13886 (TID–25874, pp 165-7) PARTICLE IDENTIFICATION IN AREA 2 BEAMS. Baker, W.; Pruss, S. (National Accelerator Lab., [Batavia], Ill.); Meunier, R. (European Organization for Nuclear Research, Geneva (Switzerland)); Meyer, D. (Michigan Univ., Ann Arbor). 1970.

In 1970 summer study.

Cherenkov counter needs of Area 2 are discussed, and a combination of DISC and threshold Cherenkov counters are recommended. (auth)

13887 (TID–25874, pp 173-5) RECOMMENDATIONS FOR ON-LINE COMPUTER FACILITIES FOR NAL. Burleson, G. (Northwestern Univ., [Evanston], Ill.); Chien, C. Y. (Johns Hopkins Univ., Baltimore, Md.); Jenkins, T.; (and others) (Case-Western Reserve Univ., Cleveland, Ohio). 1970.

In 1970 summer study.

The basic system of computers which NAL should purchase for use with on-line experiments in Area 2 is discussed. (auth)

13888 (TID–25874, pp 205-30) MUON BEAMS. Tenenbaum, J. (Stanford Linear Accelerator Center, Calif.); Pipkin, F.; Wilson, R. 1970.

In 1970 summer study.

Various features of muon beams are considered. The crucial question of an estimate of beam halo and background is discussed first. The possibilities and relationships of muon beams in Area 2 are then considered. A higher-energy muon beam transport is outlined. Finally, the effects of variations on the nominal beam in Area 1 are considered. (auth)

13889 (TID–25874, pp 315-29) STRONG-INTERACTION STUDIES WITH BUBBLE CHAMBERS AT NAL. Burnstein, R. (Illinois Inst. of Tech., Chicago); Chien, C.-Y. (Johns Hopkins Univ., Baltimore, Md.); Engelmann, R. (Argonne National Lab., Ill.); Ermolov, P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii); Minten, A. (European Organization for Nuclear Research, Geneva (Switzerland)); Panvini, R. (Brookhaven National Lab., Upton, N. Y.); Snow, G. (Maryland Univ., College Park). 1970.

In 1970 summer study.

Studies of strong interactions up to the highest energies at NAL require an active bubble-chamber program. The varieties

of experiments and some technical requirements for such a program are outlined in this report. It is recommended that an existing bubble chamber be moved to NAL to strengthen and add flexibility to the program for strong interactions, which already includes the 15-ft chamber under construction. (auth)

13890 (TID-25874, pp 331-8) NEUTRAL BEAMS GROUP REPORT. Lande, K.; Cung, V.; Frankel, S. (Pennsylvania Univ., Philadelphia); Aronson, S. (Chicago Univ., Ill.); Chien, C. Y. (Johns Hopkins Univ., Baltimore, Md.); Mischke, R. (Princeton Univ., N. J.). 1970.

In 1970 summer study.

Based on the recently proposed and other possible K^0 experiments, the establishment of two additional neutral beams in Area 2, one at 6 mrad and one at ≥10 mrad, is recommended. The possibility and desirability of a time-of-flight facility at NAL are considered. Radiation leakage due to neutral beams is evaluated. (auth)

13891 (TID-25874, pp 343-4) COMPATIBILITY OF THE CHARGED AND NEUTRAL HYPERON BEAMS. Pondrom, Lee (Wisconsin Univ., [Madison]). 1970.

In 1970 summer study.

The charged hyperon beam proposal and the neutral hyperon beam proposal are incorporated in a common floor plan. (auth)

13892 (TID-25874, pp 345-6) FEASIBILITY OF A SURVEY OF NEGATIVE HYPERON INTENSITIES IN A BEAM OF MODERATE LENGTH. Aronson, A.; Winston, R. (Chicago Univ., Ill.); Meunier, R. (European Organization for Nuclear Research, Geneva (Switzerland)); Pondrom, L. (Wisconsin Univ., [Madison]); Romanowski, T. (Argonne National Lab., Ill.); Lach, J.; Roberts, A. (National Accelerator Lab., [Batavia], Ill.). 1970.

In 1970 summer study.

This note points out that negative hyperon yields could be measured by minor modification of the forward-angle beam-survey Proposal 54. (auth)

13893 (TID-25874, pp 347-54) INFORMATION CONCERNING NEUTRINO CONFIGURATIONS AND FLUX: CONSEQUENCES FOR NEUTRINO-PHYSICS EXPERIMENTS. Burnstein, R. A. (Illinois Inst. of Tech., Chicago). 1970.

In 1970 summer study.

The current neutrino-physics proposals are considered with a view to estimating how seriously the event rate is reduced by an earth neutrino shield instead of a steel neutrino shield. A similar comparison is made for the individual physics topics contained in the proposals. As a background, information concerning the cost of uniform or composite neutrino shields is compiled together with flux estimates for some of the configurations. (auth)

13894 (TID-25874, pp 369-79) AREA 1 AS A TWO-LINE AREA. Maschke, A. (National Accelerator Lab., [Batavia], Ill.); Mischke, R. (Princeton Univ., N. J.); Morrison, R. (California Univ., Santa Barbara); Sciulli, F.; Tollestrup, A. (California Inst. of Tech., Pasadena); Tenenbaum, J. (Stanford Linear Accelerator Center, Calif.). 1970.

In 1970 summer study.

A possible two beam-line system for Area 1 is presented, and various experiments that can be done with such a system are discussed. (auth)

13895 (TID-25874, pp 381-9) FOCUSING DEVICES FOR A NEUTRINO BEAM AT NAL. Palmer, R. B. (Brookhaven National Lab., Upton, N. Y.). 1970.

In 1970 summer study.

Three focusing systems for a neutrino beam are described and compared. The dc "fish" system is found to give fluxes at least a factor of two less than the two "horn" systems. In the first of these horn systems, currents, power requirements, and stress levels are all much lower than in the second, more conventional design. The first system could operate at only 200 volts by using solid-state switching; good focusing would be provided over a 2.5-ms spill, and greater reliability should be possible. (auth)

13896 (TID-25874, pp 423-6) EXPERIMENTS IN THE MAIN RING. Mischke, R. E. (Princeton Univ., N. J.); Rust, D. (Argonne National Lab., Ill.). 1970.

In 1970 summer study.

Some comments are made about several proposals to do experiments using protons in the circulating beam. Several technical problems are reviewed, and it is emphasized that the best time to run such experiments is during the early operation of the accelerator. (auth)

13897 RADIATIVE INSTABILITY OF AN ELECTRON RING IN FREE SPACE. Korenev, I. L.; Yudin, L. A. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 8, 1268-74(1971). (In Russian).

The stability of a relativistic electron ring in an azimuthally symmetric magnetic field is considered with respect to small coherent perturbations. Expressions are derived for the increments of longitudinal and transverse instabilities. Numerical calculations of the dependence of the increments on the energy and the coefficient of the magnetic field decrease are given for some first harmonics of perturbations. For relativistic energies the radiative longitudinal instability is shown to prevail over the negative mass instability. (auth)

13898 INTERACTIONS BETWEEN ELEMENTARY PARTICLE RESEARCH AND ENGINEERING. Blewett, J. P. (Brookhaven National Lab., Upton, N. Y.). pp 289-308 of Elementary Particles. Science, Technology, and Society. /Yuan, Luke C. L. (ed.). New York; Academic Press Inc. (1971).

A brief history of accelerator development is given, and several techniques and devices resulting from the technologies of nuclear and particle physics are discussed. (J.F.P.)

13899 PRESENT STATUS OF SUPERCONDUCTING LINEAR ACCELERATORS. Citron, A. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 50-6 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The principle of linear accelerators is given and it is shown that the rf-power requirements is a dominant factor in the construction budget for such an accelerator. The economic balance can be shifted radically, if the resonators, which from the linear accelerator, are coated with superconducting material. The cost of the refrigeration now takes over as a main component of the total investment. This refrigeration power is determined by the accelerating fields and by the surface resistance of the superconducting material, which is small but not zero for high frequencies. Part of the surface resistance can be understood in terms of the theory of superconductors and leads to favorable values. Another contribution, the so-called residual resistance, depends on the way the surface is prepared and also on the field strength and it is not understood theoretically. Whereas it has not been possible so far to prepare lead surfaces which show a low surface resistance even for high fields, niobium, which has been investigated at Stanford, shows surface resistances near to the theoretical ones under certain circumstances. Therefore it seems possible to build a linear accelerator with niobium resonators, which compares favorably with conventional accelerators. Projects on this basis are under way at Stanford and at Karlsruhe. (auth)

13900 COOLING SYSTEMS OF PIPES OF ABOUT 1 TO 10 mm DIAMETER AT 1 TO 2 K WITH SUPERFLUID HELIUM. Passow, C. (Kernforschungszentrum, Karlsruhe, Ger.). pp 144-6 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The technical feasibility of using superfluid helium with its high heat conductivity for a cooling system at temperatures between 1 and 2°K is investigated theoretically and experimentally. It is shown mathematically that the two-fluid model, which describes well the conductivity in capillaries and slits of very small dimensions, should be applicable in calculations for large-scale cooling systems also. On this basis, calculations for two different cooling systems are performed. The cooling system treated can be used to cool superconducting accelerator structures, especially helix wave guides. Numerical calculations for this application have been done. In an experiment heat conduction without mass transport is measured in pipes 4 m long and 0.1 to 1.0 cm in diameter. The heat source is distributed along the pipe. Hence high-heat-flux densities on the end of the pipe are possible. The experimental results are compared with the theoretical calculations. (auth)

13901 SLAC LIQUID-HYDROGEN TARGET CONTROL SYSTEM. Pierce, W. B. (Stanford Univ., Calif.). pp 287-302 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The system concept and circuit details of the Stanford Linear Accelerator liquid-hydrogen target control system are examined. Among individual systems of the target control that are discussed are the automatic fill system and the semiautomatic vacuum system. (auth)

13902 TARGET FOR LIQUID OR GASEOUS ^{3}He AND LIQUID HYDROGEN. Buhler, S. (Institut de Physique Nucleaire, Orsay, France). pp 306-9 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

A cryogenic target to be used for nuclear research on the properties and elementary reaction of helium-3 has been built. The cryostat consists essentially of two superposed reservoirs containing liquid helium at 4.2 and 2.5 K, surrounded by a helium-vapor-cooled radiation shield and superinsulation. Beneath the reservoirs three superposed targets are placed in the cryostat axis. The targets are of flat or cylindrical shape, a combination of a copper or brass support with Havar foil of some 6 to 10 microns thickness. The cryostat is mounted on an annular pneumatic hoist that ensures positioning of any target on the beam axis. The control system of targets and hoist is essentially a pneumatic one. A modular set-up of the basic control functions that will enable versatile experimental arrangements has been developed. (auth)

13903 UNIQUE COPPER CONDUCTORS CONTROL PROTON BEAM IN NAL ACCELERATOR. Specht, Harry M. Power Eng.; 75: No. 10, 50-4(Oct 1971).

The magnets and power supply system for the NAL Synchrotron are briefly described. (W.H.K.)

13904 COMPUTER PROGRAM FOR THE SIMULATION OF HIGH-INTENSITY BEAM OF CHARGED PARTICLES IN ROTATIONALLY SYMMETRIC GEOMETRY. Sechovcov, V. (Technical Univ., Prague). Czech. J. Phys.; 21: No. 12, 1229-39 (1971).

A computer program for the calculation of particle trajectories of a beam with high density of space charge, in complicated static electric and magnetic fields with rotational symmetry is described. Careful selection of numerical methods and the comparatively general arrangement make the program applicable to a wide field of problems. As an example, the accel-decel extraction system of an ion source is solved. (auth)

13905 COLLIDING PARTICLES IN ACADEMGORODOK. Budker, Hersh. New Sci.; 52: No. 773, 84-5(9 Dec 1971).

The most recent installation in Novosibirsk is an electron–positron counter-beam accelerator in which the magnetic field turns the electrons and positrons in different directions thus saving one ring, and two beams can be accelerated in one chamber. It is considered that collisions of electrons and positron beams with up to 3500 MeV each will be possible with an accumulating ring only 22 m in diameter. Experiments planned using the machine, including producing anti-atoms and testing the limits of quantum electro dynamics, are considered. (UK)

13906 INVESTIGATION OF BEAM OF PARTICLES WITH ENERGY UP TO 70 GeV WITH SPARK SPECTROMETER. Aleksandrov, I. A.; Bolotov, V. N.; Devisheva, M. N.; (and others). At. Energ. (USSR); 31: No. 6, 589-93(Dec 1971). (In Russian).

A magnetic spark spectrometer installed in the beam of the Serpukhov Synchrotron to search for quarks is described. Measurement results on beam parameters and a comparison with calculated data are reported. Differential cross-sections for production of negative particles by protons on Al nuclei are derived. (auth)

13907 DESIGN OF TEST FIXTURES FOR ELECTRON-BEAM TREE EXPERIMENTS. Phillips, D. H.; Grannemann, W. W.; Kuhlmann, G. J. (Univ. of New Mexico, Albuquerque). Radiat. Eff.; 11: No. 2, 99-105(Nov 1971).

The experimental problems and radiation noise sources associated with flash x-ray machine (FXR) and linear accelerator (LINAC) electron-beam TREE experiments are discussed. Special testing techniques and test fixture design guidelines are presented. Wiring diagrams for a properly designed general-purpose electron-beam test fixture and control unit are shown, in addition to photographs which illustrate the geometry-dependent shielding and noise reduction techniques. Techniques for improving both electron radiation shielding and rf shielding efficiencies are represented. (auth) (UK)

13908 STUDIES IN THE X-UV DOMAIN WITH LARGE ELECTRON ACCELERATORS. Cauchois, Y. (Faculte des Sciences, Paris). Mem. Soc. Roy. Sci. Liege; 1: No. 2, 105-29(1971). (In French).

Recent developments in the theoretical and practical study of synchrotron radiation are reviewed. Basic data on this radiation are first presented. The validity of the classical theory is discussed and compared with experimental data. The development of studies using the orbital radiation of large electron synchrotrons is summarized, with emphasis on the results obtained with the Frascati synchrotron. (J.S.R.)

13909 ELECTRON-OPTICAL PROPERTIES OF A QUADRUPLET CONSISTING OF SHORT QUADRUPOLE–OCTUPOLE LENSES. Fishkova, T. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 843-5(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 1068-70(May 1971).

Analytical expressions are obtained in the short-lens approximation for the electron-optical parameters of a quadruplet which is analogous to an axially symmetrical lens as regards first-order properties. The quadruplet consists of four superposed quadrupole-octupole lenses. Expressions for the third-order spherical aberrations of such a quadruplet are given and a correction system using three octupole lenses is described. (auth)

13910 EFFECT OF FRINGE FIELDS ON ABERRATIONS OF QUADRUPOLE LENSES. Ovsyannikova, L. P.; Yavor, S. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 803-6(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 1023-7(May 1971).

Expressions are derived for the spherical aberration coefficients of quadrupole lenses accurate to terms of fifth order. The models of the compound bell and trapezium are utilized in the calculations in order to approximate the dependence of the field on the longitudinal coordinate. (auth)

13911 IMPROVEMENTS IN THE OPTICAL CHARACTERISTICS OF A 360-MeV ACCELERATOR BEAM. Dem'yanenko, G. K.; Rubtsov, K. S.; Ryabka, P. M. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 792-4(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 1008-11(May 1971).

The effect of energy inhomogeneity, phase extent, transverse dimensions, and angular divergence of a beam injected into an electron linear accelerator on the finite optical characteristics of that beam were investigated. In order to produce beams of small dimensions (~1 mm) and small angular divergence (less than 10^{-4} radian), it is essential to reduce the phase width of the bunches, the energy spread, and the emittance of the beam to be injected, in addition to removing transverse perturbations of the beam in the asymmetrical fields of the matching elements of the accelerating sections. (auth)

13912 PHASE MOTION OF A HIGH-INTENSITY BEAM IN A STRONG-FOCUSING PROTON SYNCHROTRON. Pashkov, P. T.; Shukeilo, I. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 787-91(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 1002-7(May 1971).

The effect of space charge on the phase motion of the beam in a strong-focusing proton synchrotron has been studied. The solution of the phase equation is obtained with the action of the electric field of the bunches taken into account for nonlinear synchrotron oscillations. The numerical calculations were performed on an MN-7 analog computer for the Serpukhov synchrotron at a beam intensity $N = 5 \times 10^{13}$ protons/burst. (auth)

13913 INVESTIGATION OF RADIAL STABILITY IN A SYSTEM WITH DRIFT TUBES AND MAGNETIC COUPLING. Gavrilov, N. M.; Zubovskii, V. P. (Moscow Engineering-Physics Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 5, 795-7(Nov 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 5, 1012-15(May 1971).

The possibility of achieving radial stability in the case of a beam of prebunched particles moving through a structure with drift tubes and magnetic coupling at the periphery is demonstrated. The limiting current for stable motion is calculated. (auth)

13914 SYMPOSIUM ON THE USE OF CYCLOTRONS IN MEDICINE, LONDON, SEPTEMBER 20, 1969. London; Medical Research Council (1969). 105p. (CONF-690979).

Separate abstracts were prepared for 6 of the 14 papers presented. The remaining 8 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 11577, 11836, 11837, 12427, 13915, and 13916.

13915 ESTABLISHMENT OF SUITABLE NEUTRON FLUXES FOR WHOLE-BODY NEUTRON ACTIVATION ANALYSIS, USING A CYCLOTRON AS A NEUTRON SOURCE. Chamberlain, M. S.; Fremlin, J. H.; Holloway, I. (Univ. of Birmingham, Eng.). 8p of Symposium on the Use of Cyclotrons in Medicine. London; Medical Research Council (1969).

From Symposium on the use of cyclotrons in medicine; London, England (20 Sep 1969). See CONF-690979.

A method is described for producing a suitable flux used for carrying out fast neutron activation analysis of total body calcium in living subjects. By determining the ratio of calcium to sodium, compensation was made for possible changes of conditions between irradiations. (UK)

13916 DEVELOPMENT OF THE PULSED BEAM FACILITY FOR THE BIRMINGHAM 60 INCH CYCLOTRON. Chen, N. S.; Ettinger, K. V.; Fremlin, J. H. (Univ. of Birmingham, Eng.). pp 10p of Symposium on the Use of Cyclotrons in Medicine. London; Medical Research Council (1969).

From Symposium on the use of cyclotrons in medicine; London, England (20 Sep 1969). See CONF-690979.

The pulsed beam facilities and experiments performed at Birmingham with pulsed charged particle and neutron beams are briefly described. The elements C, N, F, Na and Mg were measured in bones and teeth using charged particle beams and prompt gamma detection methods. A large number of elements were scanned for μsec and nsec excited states suitable for analytical applications. The neutron experiments aimed at the detection of γ-rays from the decaying isomeric state of sodium. (UK)

13917 APPLICATIONS OF CRYOGENICS TO HIGH-ENERGY NUCLEAR PHYSICS. Atkinson, H. H. (Rutherford High Energy Lab., Chilton, Eng.). pp 395-413 of Advanced Cryogenics. /Bailey, C. A. (ed.). New York; Plenum Publishing Corp. (1971).

Topics include applications to particle accelerators (vacuum systems, superconductive linacs, superconductive synchrotrons, and energy storage for synchrotrons); application to beam handling and analysis (quadrupoles and bending magnets and superconductive rf separators); applications to equipment for experiments (cryogenic, liquid targets, bubble chambers using cryogenic liquids, spark chamber magnets, Cherenkov counters, very high magnetic fields, reduction of electrical noise in detectors, and hydrogen moderators for reactors); and polarized nuclear targets (solid effect targets, cryogenic problems, limitations of present targets, and improved access). (W.H.K.)

13918 SYSTEM FOR STIGMATICALLY AND ACHROMATICALLY DISPLACING PARTICLES. Leboutet, Hubert (to Thomson-CSF). French Patent 2,058,485. 3 May 1971. Filed 10 Sep 1969. (In French).

An apparatus for stigmatically and achromatically magnetically displacing a beam of particles in a plane is described. Four electromagnets are contained in a symmetrical configuration perpendicular to the plane of displacement. Applications are envisaged principally in the field of particle accelerators for nuclear research and industrial and medical gammagraphy. (France)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 11951, 13115, 13389, 13398, 13423, 13462, 13840, 13978, 14075, 14078, 14551, and 14557.

13919 (CONF-710402-(Vol.1), pp I.1-3) NEUTRONS: A GENERAL BACKGROUND. Dessauer, G. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

After Rutherford succeeded in ejecting protons from an atomic nucleus some fifty years ago, it took over a decade before Chadwick found the other nuclear constituent, the neutron. However, within a relatively short time thereafter we learned to produce neutrons in vast quantities and to control their release for our benefit and for the benefit of our environment. Besides reactors and accelerators, portable neutron sources are becoming available in increasing quantity and strength. Among the latter are α,n and γ,n sources powered by reactor-produced radionuclides, and ^{252}Cf, which emits neutrons in spontaneous fission. (auth)

13920 (CONF-710402-(Vol.1), pp I.53-64) REVIEW OF MEASUREMENTS OF ABSOLUTE NEUTRON EMISSION RATES AND SPECTRA FROM NEUTRON SOURCES. Caswell, Randall S. (National Bureau of Standards, Washington, D. C.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The measurement of the absolute neutron emission rate of neutron sources has been reviewed with emphasis on the manganous sulfate bath method, and is found to be in good quantitative shape. In precision applications, such as ν (neutrons/fission) and certain cross section measurements, higher accuracy would, nevertheless, be desirable. Significant improvement in the accuracy of (α,n) source calibrations could be obtained by resolution of the discrepancy on the magnitude of the fast neutron loss to nuclear reactions in the manganous sulfate bath. Recent developments in the techniques of measuring spectra of neutron sources have led to the beginning of reliable measurements in the energy region below 1 MeV. The source spectrum measurement field is, nevertheless, in semi-quantitative state. Further intercomparisons of measurement methods are needed, and also, the resolution of a discrepancy on the neutron energy spectrum for the ^{252}Cf spontaneous fission neutron source. (auth)

13921 (JAERI-4043 (3rd Ed.)) BIBLIOGRAPHY FOR THERMAL NEUTRON SCATTERING. Third Edition, 1971. (Japan Atomic Energy Research Inst., Tokyo). Nov 1971. 85p. Dep. NTIS (U. S. Sales Only).

The Thermalization Group of Japanese Nuclear Data Committee has continued the compilation and publication of the bibliography for thermal neutron scattering. The first and second editions of the bibliography (JAERI 4043) have been published. This is the third edition which contains nearly 1300 articles, including the first and second edition and all additions collected by the group members until June, 1971. These articles are needed for the data evaluation which is one of the main activities of the committee. (auth)

13922 (KFK-1445) NUMERICAL SOLUTION OF THE THREE DIMENSIONAL NEUTRON TRANSPORT EQUATION. Kinnebrock, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jul 1971. 8p. Dep. NTIS (U. S. Sales Only).

A method of solving the three-dimensional neutron transport equation by using time-saving difference equations is described. The discrete angular flux is computed in 14 directions. It is shown how to use a set of 24 angular directions identical with those proposed by B. G. Carlson and K. D. Lathrop for S_4-calculations. (auth)

13923 (LA-DC-13275) SIMULATION OF LOW-ENERGY PHOTON TRANSPORT AND THE SIMULATION OF THE ADJOINT NEUTRON TRANSPORT EQUATION WITH MONTE CARLO. Carter, L. L.; Cashwell, E. D.; Schrandt, R. G. (Los Alamos Scientific Lab., N. Mex.). Nov 1971. 10p. (CONF-711125-1). Dep. NTIS.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

Calculations of low-energy photon transport in air and in iron using the MCP code are presented. Also the MCNA code for simulation of the adjoint neutron transport equation is used to determine the neutron dose on the ground as a function of the angular distribution of a point source. (J.F.P.)

13924 (ORNL-TM-3530) METHODS OF BIASING SECONDARY GAMMA-RAY PRODUCTION IN COUPLED NEUTRON GAMMA-RAY MONTE CARLO CALCULATIONS. Solomito, M.; Stevens, P. N.; Straker, E. A.; Burgart, C. E.; Cramer, S. N. (Oak Ridge National Lab., Tenn.). 8 Dec 1971. 81p. Dep. NTIS.

Methods for applying importance sampling techniques to secondary γ-ray generation in coupled, neutron-γ-ray Monte Carlo transport calculations were developed and evaluated. The Boltzmann transport equation is presented in an integral-matrix form which defines a set of coupled neutron-γ-ray, multigroup equations and provides the basis for the coupled Monte Carlo random walk. Three methods of biasing the production of secondary γ rays which make use of importance functions obtained from discrete ordinates adjoint calculations are formalized. These methods employ importance sampling techniques which include alteration of the γ-ray generation probabilities, non-absorption weighting, and a combination of splitting and Russian roulette. These three methods are evaluated using the multigroup, Monte Carlo MØRSE in the solution of a deep-penetration shielding problem in concrete. All three methods are shown to be more efficient than the standard method of biasing the secondary γ-ray production in the MØRSE code. The methods varied from a factor of 1.3 to 40.0 better than the standard method based on the running time of the code and variance of the answer obtained. (auth)

13925 PHASE SHIFT IN THE TIME SPECTRUM OF NEUTRONS DIFFRACTED BY A VIBRATING SINGLE CRYSTAL. Michalec, R. (Nuclear Research Inst., Rez, Czech.); Sedlakova, L.; Cech, J.; Petrzilka, V. Phys. Lett.; 37A: No. 5, 403-5 (20 Dec 1971).

The time modulation of neutrons diffracted by a longitudinally vibrating bar-shaped quartz single crystal was investigated. The phase shift of the neutron time spectrum with respect to the absolute value of the sinusoidally varying strain of the vibrating sample was observed. (auth)

13926 TRANSMISSION AND REFLECTION COEFFICIENT WITH ANISOTROPIC SCATTERING. El-Wakil, S. A. (Central Research Inst. for Physics, Budapest). Atomkernenergie; 18: No. 3, 215-18(Nov 1971).

The boundary source method which is based on Placzek lemma is used to obtain the reflection and transmission coefficients for slab geometry. The Green function for anisotropic scattering kernel is obtained by using the Fourier integral transform. The resultants are a set of linear equations obtained on the invariance principle of Chandrasekhar. (auth)

13927 PERENOS BYSTRYKH NEITRONOV V PLOSKIKH ZASHCHITAKH. (Transport of Fast Neutrons in Plane Shields). Germogenova, T. A.; Degtyarev, S. F.; Orlov, V. V.; (and others). Moscow; Atomizdat (1971). 292p.

The propagation of fast neutrons in plane shielding and methods of solving transport equations in plane geometry for angular neutron fluxes are discussed. The treatment includes methods of discrete ordinates, spherical harmonics, etc., the solution of conjugate transport equations, and perturbation theory for shielding functionals. Three-dimensional angular and energy distributions of fast neutron fluxes are analyzed for various shielding materials. Design of multiple experiments and semiempirical laws are presented as an aid in exploiting the concept of a field of fast neutrons inside and outside of plane shielding. (tr-auth)

13928 EXPERIMENTAL METHOD FOR ANISOTROPY IN NEUTRON FLUX WITH USE OF RESONANCE FOILS. Kaneko, Yoshihiko; Kitadate, Kenji. Nippon Genshiryoku Gakkaishi; 13: No. 11, 619-26(Nov 1971). (In Japanese).

A new technique is developed to determine the P_0 and P_1 components of the neutron flux in a slowing down energy region. The principle of the new technique is based on relating the activities induced on each of a set of three thin Au-foils arranged in sandwich to both of the components of the neutron flux expanded into Legendre polynomials. Applying the technique, the spatial distribution of an anisotropic source neutrons producing thermal neutrons in a light water tank of slab geometry was measured with fairly good accuracy. It is concluded from error estimations that this technique is validly applicable in general usage. (auth)

13929 RATIO OF THE FLUX DENSITY OF THERMAL AND INTERMEDIATE NEUTRONS IN THE VICINITY OF NEUTRON SOURCES IN WATER. Bortfeldt, H. J.; Matzke, M. (Physikalisch-

Technische Bundesanstalt, Brunswick). Z. Naturforsch.; 26a: No. 7, 1205-9(Jul 1971). (In German).

Measuring the cadmium ratio as function of the distance from (α,n) neutron sources in water yielded a clearly distinguishable maximum followed by a small decrease with increasing distance. This behavior can be explained by a calculation in diffusion approximation using special source terms. (auth)

13930 NEUTRON THERMALIZATION IN FACE CENTERED CUBIC (FCC) METAL HYDRIDES. Keinert, J. (Univ., Stuttgart). Atomkernenergie; 18: No. 4, 261-6(1971).

The extreme operating conditions of compact power reactors require metal hydrides as moderators; yttrium hydride, especially, has a very great thermal stability. For this moderator and for cerium hydride, an attempt was made to find a simple analytic frequency distribution of Debye- and Gaussian-type. To evaluate the different parameters of this model, the known unit cells were used. Taking into account the Doppler effect, hydrogen–hydrogen interactions, and measured scattering cross sections, the parameter sets were derived for $\rho_H(\omega)$. (auth)

13931 MEASUREMENTS OF NEUTRON SPECTRA IN A BARYTES CONCRETE PILE. Hayashi, Shu A.; Kobayashi, Katsuhei; Yamamoto, Shuji; Kimura, Itsuro. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 107-12(1971).

Neutron spectra in and out of a barites concrete pile were measured by the time-of-flight method with an electron linear accelerator. By using a BF_3 counter bank for lower neutron energy ranges and a ^6Li glass scintillation counter for higher energies, neutron spectra from several meV to about 300 keV were obtained. The spectrum of neutrons in the barites pile was found to consist of a pure Maxwellian, a 1/E distribution with a few resonance dips caused by barium, and a higher part above 100 keV. (7 figures). (R.W.R.)

13932 MEASUREMENT OF NEUTRON SPECTRUM IN AN ANHYDROUS SODIUM CARBONATE PILE. Kanda, Keiji; Nakagome, Yoshihiro; Kimura, Itsuro; Nanjyo, Tsutomu. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 25-33(1971).

The neutron spectrum in an anhydrous sodium carbonate pile was measured near the energy of the sodium resonance at 2.85 keV with the time-of-flight method by an electron linac. The neutron beam was extracted from the center of the pile, which had the shape of a 14-hedron looking like a sphere of 65 cm equivalent diameter. Neutrons were detected after 22 m flight with a ^6Li glass scintillation counter. Measured spectrum was compared with calculated results, and they were in good agreement. Theoretical calculations were performed in two methods. One was based on a simple equation of neutron collision density using the differential cross section in KFK-750. The other was a one-dimensional S_n calculation using DTF-IV code and the cross section set of ABBN. (auth)

13933 PRODUCTION OF AN Sb–Be NEUTRON SOURCE OF PLANE TYPE AND MEASUREMENT OF THE NEUTRON AGE IN WATER. Kanda, Keiji; Hayashi, Masatoshi; Okumura, Kiyoshi. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 17-24(1971).

A planar antimony–beryllium neutron source was made, which consists of a beryllium plate 25 cm in diameter and 0.5 cm in thickness, with 6 rods of antimony encased in aluminum tubes. The antimony was irradiated at the KUR. By using this neutron source, the neutron age to indium resonance energy (1.46 eV) in water was measured by the infinite-plane-detector method, and the value 5.38 ± 0.17 cm^2 was obtained. The measured age was compared with the theoretical values, 4.755 cm^2 and 5.291 cm^2, calculated with Greuling–Goertzel and Selengut–Goertzel approximations. (auth)

13934 MEASUREMENT OF NEUTRON SPECTRA IN A SPHERICAL ALUMINA PILE. Kimura, Itsuro; Hayashi, Shu A.; Kobayashi, Katsuhei; Yamamoto, Shuji; Nishihara, Hiroshi. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 99-106(1971).

A 60-cm spherical vessel filled with alumina powder was used to measure the neutron cross section. The purpose of the experiment was to investigate the feasibility of checking cross section data on important reactor materials by using powder assemblies. The layout of the experiment and a block diagram for the electronics are given. Measurements are compared with preliminary calculations using the YOM cross-section set. It is found that the observed spectrum of neutrons extracted from the central region agrees reasonably with the YOM spectrum above 10 keV; for neutrons escaping from the surface of the assembly, the agreement is poorer; for both cases, the observed spectra are considerably larger than the YOM spectra below 10 keV. (5 figures, 1 table, 1 photograph). (R.W.R.)

13935 EFFECT OF A COLLIMATOR ON FAST NEUTRONS. Balakhnichev, S. N.; Banin, A. G.; Evfanov, V. Ya.; Rudakov, A. N.; Yanovskii, A. P. At. Energ. (USSR); 31: No. 5, 523-5 (Nov 1971). (In Russian).

The neutron spectra of a number of Pu–Be(α,n) sources were compared in "open geometry" and with a collimator with an aperture of 0.26 steradian. Measurements made with a spectrometer were compared with calculations by the Monte Carlo method. From the spectral distribution of neutrons it was evident that scattering in a collimator increased the intensity in the soft region. (K.S.W.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 13026, 13514, 13521, 14006, 14078, 14095, 14180, 14182, and 14204.

13936 (COO–535-653) TECHNICAL PROGRESS REPORT. (Colorado Univ., Boulder. Nuclear Physics Lab.). 1 Nov 1971. Contract AT(11-1)-535. 149p. Dep. NTIS.

A summary of research on theoretical and experimental aspects of nuclear physics is presented. A list of publications is included. (J.F.P.)

13937 (COO–2130-9) ATOMIC AND NUCLEAR RESEARCH WITH ACCELERATORS. Interim Progress Report, January 1, 1971–November 1971. Leachman, Robert B. (Kansas State Univ., Manhattan. Dept. of Physics). Nov 1971. Contract AT-(11-1)-2130. 20p. Dep. NTIS.

Research on atomic collisions and nuclear reactions is summarized. A list of publications is included. (J.F.P.)

13938 (JINR–P1-6131) ELASTIC SCATTERING OF 100 MeV $\pi^\pm$ MESONS BY HELIUM. Kulyukin, M. M.; Lyashenko, V. I.; Nichitiu, F.; Piragino, G.; Pontecorvo, D. B.; Falomkin, I. V.; Shcherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The $(\pi^\pm, {}^4He)$ elastic differential cross sections were measured at (97 ± 6) MeV. The experimental apparatus consists of two helium-filled streamer chambers: the first one at atmospheric pressure in a bending magnet to measure the momenta of the incident pions and the second one at 4 atm, surrounded by a hodoscope of scintillation counters (covering a solid angle of about 1.4 sr). The trigger for the streamer chambers is given by the coincidence between the counters defining the pion beam and any one counter of the hodoscope. The contamination of muons and electrons in the pion beam is measured with a lucite Cherenkov counter. Time-of-flight technique is used to select the pions. About 50000 photographs have been taken with about 1250 events of elastic scattering at the $25^0 \leq \theta_\pi \leq 165^0$ angular region. The results are compared with those obtained by other authors. (auth)

13939 (JPRS–54305, pp 42-62) EFFECTIVE CROSS SECTIONS OF REACTION (n, 2n). Sluchevskaya, V. M. Translated from Byull. Tsentra Yadern. Dannym; No. 6, 215-35(1969).

Effective cross sections for (n,2n) reactions on A = 2 to 209 nuclei for fast neutron energies are presented in tabular form. (J.W.R.)

13940 (LBL-500, pp 359-61) MEASUREMENTS OF THE SPIN CORRELATION PARAMETERS A_{xx} AND A_{yy} FOR d-p SCATTERING AT $E^d_{lab} \sim 29$ MeV (PRELIMINARY RESULTS). Chauvin, J.; Fruneau, M.; Garreta, D. (Commissariat a l'Energie Atomique, Saclay (France). Centra d'Etudes Nucleaires). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Spin correlation coefficients were measured by scattering the vector-polarized deuteron beam of the Grenoble AVF cyclotron on a polarized proton target. (auth)

13941 NEUTRON–NEUTRON SCATTERING LENGTH FROM A KINEMATICALLY COMPLETE MEASUREMENT OF THE $^3H(d,\tau n)n$ REACTION. Groetzschel, R.; Kuehn, B.; Moeller, K.; Moesner, J.; Schmidt, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys.; A176: No. 2, 261-72(1971).

Coincident n–^{3}He spectra were measured from the reaction $^3H(d,^3He)n$ at $E_d = 13.43$ MeV, $\vartheta_{^3He} = 29°$ and $\vartheta_b = 65.4°$. The Migdal–Watson approximation was used for data analysis. The value $a_{nn} = -16.0 \pm 1.0$ fm for the $^1S_0$ neutron-neutron scattering length was deduced. (auth)

13942 POLARIZATION OF NEUTRONS FROM THE d–t REACTION AND IN n–p SCATTERING. Ryu, N.; Sanada, J.; Hasai, H.;

(and others) (Hiroshima Univ.). Nucl. Phys.; A180: No. 2, 657-67(1972).

The polarization of 32 MeV neutrons from the d-t reaction has been measured using n-He scattering at an angle of 130° (lab). A He gas scintillator was used as a scatterer, and the scattered neutrons were measured by counting the He recoils which were coincident with pulses from the side detector and which were synchronized with the deuteron beam bunch. Polarizations in n-p scattering have been measured using the polarized neutrons at angles of 30°, 40° and 50° (lab). (auth)

13943 ^{4}He ^{3}He n COUPLING CONSTANT AND THE MESONIC CONTRIBUTION FROM NUCLEON ^{4}He FORWARD DISPERSION RELATIONS. Locher, M. P. (SIN, Zurich). Nucl. Phys.; B36: No. 2, 634-40(1972).

Forward dispersion relations for nucleon-^{4}He scattering have been analyzed for $0 < E_{lab} < 600$ MeV with the help of new experimental data. Improving over a previous analysis restricted to $E < 50$ MeV the ^{4}He^{3}He n coupling constant is determined unambiguously as $r = 3.2 \pm 0.4$ in agreement with information from stripping reactions. Moreover the strength of uncorrelated three nucleon exchange and the summed strength of mesonic exchange is determined. (auth)

13944 COMPARISON OF THE VECTOR ANALYSING POWERS OF THE MIRROR REACTIONS ^{3}H($\vec{d}$,n)^{4}He AND ^{3}He($\vec{d}$,p)^{4}He. Hilscher, D.; Quin, P. A.; Davis, J. C. (Univ. of Wisconsin, Madison). Nucl. Phys.; A173: No. 1, 216-24(1971).

The vector analyzing power of the reaction ^{3}H($\vec{d}$,n)^{4}He has been measured for laboratory angles between 25 and 155° at deuteron energies of 6 and 10 MeV. For the mirror reaction ^{3}He(d,p)^{4}He, measurements were performed at the same deuteron energies for laboratory angles between 105 and 150°. For the angles between 105 and 150° the average ratio of the vector analyzing power of ^{3}He($\vec{d}$,p)^{4}He to that of ^{3}H(d,n)^{4}He is 1.016 ± 0.015 at 6 MeV and 1.035 ± 0.020 at 10 MeV. At all angles the measured vector analyzing power of the ^{3}H($\vec{d}$,n)^{4}He reaction agrees to within ±0.025 with results previously obtained at this laboratory for the ^{3}He($\vec{d}$,p)^{4}He reaction. (auth)

13945 NEUTRON-HELIUM SCATTERING. Cramer, D. S.; Cranberg, L. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A180: No. 1, 273-81(1972).

Relative differential cross sections of neutrons elastically scattered from ^{4}He were measured at neutron energies of 0.55, 0.84, 1.16 and 1.33 MeV. The scattered neutrons were detected in a time-of-flight spectrometer for c.m. angles ranging from 25° to 161°. The relative differential cross sections are compared to curves generated from phase shifts published elsewhere. (auth)

13946 R-MATRIX FORMULATION AND PHASE SHIFTS FOR n-^{4}He AND p-^{4}He SCATTERING FOR ENERGIES UP TO 20 MeV. Stammbach, Th.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.). Nucl. Phys.; A180: No. 1, 225-40(1972).

An R-matrix formulation for a single level with a background approximation has been used to analyse n-^{4}He and p-^{4}He elastic scattering data below the inelastic thresholds near 22 MeV. For every partial wave a single level and a distant pole contribution constant with energy has been employed. Simple relations between neutron and proton scattering parameters have been sought to possibly derive more dependable values for neutron phase shifts and analysing powers at energies where little experimental information exists. The R-matrix parameters corresponding to ^{5}He and ^{5}Li ground and 1st excited states, phase shifts up to 20 MeV and neutron analysing powers up to 15 MeV are given in tabular form and are compared to results of earlier analyses. Differences in n-^{4}He phase shifts are discussed and shown to be due to a scarcity of accurate neutron scattering data above 11 MeV. Some typical fits to n-^{4}He scattering data are shown. (auth)

13947 BINDING ENERGY DIFFERENCE OF ^{3}H AND ^{3}He, SCATTERING LENGTHS, AND CHARGE SYMMETRY OF NUCLEAR FORCES. Okamoto, K.; Pask, C. (Univ. of New South Wales, Kensington, Australia). Ann. Phys. (N. Y.); 68: No. 1, 18-56(Nov 1971).

The electromagnetic energy difference between ^{3}H and ^{3}He is studied in relation to the ^{1}S scattering length. Special attention is paid to the model dependence of the results. Previous calculations of the Coulomb energy of ^{3}He (E_c) made after 1964 are all examined, some being corrected or improved. Although many different methods were used, all the values of E_c thus summarized are reasonably close to each other, this result indicating model independence. The most probable value is $E_c \approx 0.62$ to 0.66 MeV. Subtracting this from the binding energy difference between ^{3}H and ^{3}He (Δ) = 0.764 MeV yields, the difference $\Delta - E_c \approx 0.10$ to 0.14 MeV. Various corrections are estimated, but are found to be too small to explain this discrepancy. Magnetic interactions, including higher-order terms, are also investigated and are found to be negligible. Hence, the discrepancy is real and indicates the existence of charge asymmetry of nuclear forces, in contrast to the support for charge symmetry given by the approximate equality of the neutron–neutron and proton–proton scattering lengths (a_{nn} and a_{pp}). By using previous results and new calculations, it is demonstrated that the $\Delta - E_c$ discrepancy can be accounted for by using charge asymmetric potentials due to electromagnetic mixings of mesons. The equality $a_{nn} \approx a_{pp}$ is preserved. An explanation of the $\Delta - E_c$ difference in terms of a polarization of the proton charge distribution inside the nucleus is also investigated. The $\Delta - E_c$ discrepancy cannot be reconciled with $a_{nn} \approx a_{pp}$ in this case. (64 references) (auth)

13948 RADIATIVE PION CAPTURE IN ^{4}He. Raiche, Arthur; Werntz, Carl (Catholic Univ., Washington, D. C.). Phys. Rev., C; 4: No. 6, 2003-10(Dec 1971).

The radiative-pion-capture rate from a number of low-lying Bohr orbits in ^{4}He is calculated. It is shown that the peak in the γ spectrum is caused by transitions to broad 2^- and 1^- resonances in ^{4}He. The angular correlation of the low-energy neutrons with the direction of the γ ray is shown to be strongly dependent on the orbital-angular-momentum value of the Bohr orbit from which capture occurs, thus affording an independent check of atomic deexcitation studies in pionic atoms. (auth)

13949 EXCHANGE EFFECTS IN ^{3}He + ^{4}He SCATTERING. Tang, Y. C. (Univ., Tuebingen, Ger. Univ. of Minnesota, Minneapolis); Brown, Ronald E. Contracts AT(11-1)-1764; AT(11-1-1265. Phys. Rev., C; 4: No. 6, 1979-84(Dec 1971). (COO–1265-113).

The elastic scattering of ^{3}He by ^{4}He at 44.5 MeV (c.m.) is considered within the resonating-group formalism. The existence of open reaction channels is taken into account approximately by the introduction of a phenomenological local imaginary potential into the usual resonating-group formulation of the scattering problem. By choosing the shape and strength of this potential in a reasonable manner, it is found that a fairly good fit to the experimental differential cross section can be obtained in both the forward and the backward directions. From this study it is also found that the contribution to the differential cross section at backward angles comes mainly from exchange processes which are contained in the resonating-group formalism through the use of a totally antisymmetrized-wave function. The real part of the phase shift is found to have a distinct odd-even feature, and from this it is shown that if one wishes to describe the experimental scattering data by using a complex local potential, then the real part of this potential must have a significant amount of Majorana space-exchange component. (auth)

13950 BINDING ENERGY OF ^{3}H AND n-d-DOUBLET SCATTERING LENGTH WITH CHARGE-DEPENDENT FORCES. Dabrowski, J. (Inst. for Nuclear Research, Warsaw. International Center for Theoretical Physics, Trieste, Italy); Fedorynska, E.; Haensel, P.; Hassan, M. Y. M. Phys. Rev., C; 4: No. 6, 1985-7(Dec 1971).

A simple model of an S-state separable n-p and n-n interaction, with a hard-shell repulsion in the singlet state, is applied to study the effect of the charge dependence of nuclear forces on the ^{3}H ground-state energy E_T, and on the n-d–doublet scattering length ^2a. Several values of the n-n–singlet scattering parameters—all within the range of recent experimental estimates—have been used in fixing the parameters of the n-n interaction. All the resulting values of E_T and ^2a stay close to the Phillips line. This indicates that the charge dependence is not the factor which could help us in accounting for the new experimental values of ^2a and E_T. (auth)

13951 NUCLEAR-DEUTERON QUASIFREE SCATTERING IN THE REACTION d + d → d + p + n AT LOW BOMBARDING ENERGIES. Valkovic, V.; Duck, I. M.; Sweeney, W. E.; Andrade, E.; Phillips, G. C. (Rice Univ., Houston, Tex.). Phys. Rev., C; 4: No. 6, 2289-91(Dec 1971).

Neutron-deuteron and proton-deuteron coincidence spectra in the reaction d + d → d + p + n were measured simultaneously for $E_d = 6.0–13.0$ MeV and $\theta_1 = -\theta_2 = 20°$. The results are discussed in terms of nucleon–deuteron quasifree scattering. (auth)

13952 PHOTODISINTEGRATION OF THE TRINUCLEONS. Raghavan, S. S.; Srivastava, B. K. (Indian Inst. of Tech., Kharagpur). Phys. Rev., C; 5: No. 1, 12-16(Jan 1972).

The photodisintegration integrated (σ_{int}) and bremsstrahlung-weighted (σ_b) cross sections of the trinucleons (^{3}H and ^{3}He) are calculated by applying the sum rules of Levinger and Bethe. The ground state of the trinucleon is assumed to be a mixture of symmetric S state, the mixed symmetric S′ state, and the D states; the radial dependence of all these states being (a) Gaussian and (b) Irving. The parameters of the radial part of these wave functions are obtained from a variational calculation of the binding energy of the triton by using the velocity-dependent potential of Nestor et al. The results for σ_{int} show good agreement with experiments. A comparison with similar calculations using hard-core potentials shows the inability of σ_{int} calculations to distinguish between hard-core and velocity-dependent potentials. This feature of σ_{int} calculations, which is common at least to all the nuclei in the 1s shell, is explained in terms of the well-known range–depth relationship for the two-body potentials. (auth)

13953 D(p,2p)n REACTION AT 14.45 MeV AND THE AMADO MODEL. Margaziotis, D. J. (California State Coll., Los Angeles); Young, J. C.; Slaus, I.; (and others). Phys. Lett.; 37B: No. 3, 263-5(29 Nov 1971).

Data have been obtained for the reaction D(p,2p)n at E_p = 14.45 MeV at $\theta_3 = \theta_4 = 25°$, 30°, 35° and 43°. The results are compared with calculations using the Amado model, the ordinary truncated multiple-scattering series and a modified truncated series, which includes the p-d initial state interaction. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 13521, 13936, 13937, 13939, 14024, 14070, 14075, 14078, 14095, 14157, 14180, 14182, 14183, 14204, 14219, 14229, and 14239.

13954 (AECD/EP-20) NEUTRON ENERGY TABLES FOR ^{7}Li(p,n)^{7}Be* REACTION. Enayetullah, M.; Hussain, Muhtasham (Atomic Energy Centre, Dacca (Pakistan)). Jan 1971. 10p. Dep. NTIS (U. S. Sales Only).

Tables of neutron energies were prepared for the ^{7}Li(p,n)^{7}Be* reaction for the energy range 2.378 to 3.0 MeV. They give neutron energies in steps of 10 keV of proton energy for the neutrons emitted at angles of 0 to 180° in 10° intervals. (auth)

13955 (CEA-N-1474) REACTIONS INDUCED BY Li IONS. Bassani, Giancarlo (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sep 1971. 49p. (In French). (CONF-710441-1). Dep. NTIS (U. S. Sales Only).

From Scientific conference on the use of tandem accelerators; Pont-a-Mousson, France (28 Apr 1971).

Experimental results obtained on Li-induced transfer reactions at energies much greater than the Coulomb barrier are reviewed. Tables published before April 1971 containing information and references on transfer reactions and elastic scattering experiments are given. The reaction mechanism is complex; if unambiguous spectroscopic information is to be extracted, an essential, but not necessarily sufficient, condition is an energy resolution better than the intrinsic width of the separation of the levels. This condition was satisfied, and important results were obtained for two-, three-, and four-nucleon-transfer reactions. The work undertaken using different simplified models to elucidate the reaction mechanism is briefly reviewed. The reaction cross sections decrease so rapidly with increasing A that experiments with A ~ 40 are not considered feasible at the moment. However, it has been demonstrated that for lighter nuclei the use of Li projectiles opens up fields of research hitherto unexplored. (France)

13956 (INFN/BE-67/10) (n,p) CROSS SECTIONS FOR ~14-MeV NEUTRONS. Cuzzocrea, P.; Notarrigo, S.; Perillo, E. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 21 Jul 1967. 20p. Dep. NTIS (U. S. Sales Only).

A table of data from the literature for (n,p) cross sections in the range 13.9 to 15.0 MeV is presented. These data are available up to June 1967. (J.F.P.)

13957 (KFK-1426) INVESTIGATION OF PROTON SHELLS IN NUCLEI IN THE NEIGHBORHOOD OF THE 1p CLOSED SHELL BY (d,^{3}He) REACTIONS. Hartwig, D. (Kernforschungszentrum, Karlsruhe (West Germany). Zyclotron-Laboratorium). Jun 1971. 58p. (In German). Dep. NTIS (U. S. Sales Only).

The (d,^{3}He)-reactions on the enriched target nuclei ^{16}O, ^{18}O and ^{15}N were studied with the 52-MeV deuterons of the Karlsruhe Isochronous Cyclotron. By the use of gas targets and a special diaphragm-system it became possible to measure with a small background up to high excitation energies. Thus nearly the complete 1p- and sd-reaction strengths could be observed, which are fractionated into a relatively small number of levels. Furthermore, very small transitions were found, leading to known states up to $E_x \approx 10$ MeV and to many still higher excited states. Their angular distributions show no structure and indicate complicated reaction mechanisms. Spins and parities were assigned for the first time to nine levels of ^{17}N, to the states at 8.32 MeV, 10.43 MeV (or 10.45 MeV) and 11.35 MeV of ^{14}C, as well as to the level at 12.52 MeV in ^{14}N. In contradiction to quotations in the literature, the levels at 9.93 MeV and 10.70 MeV of ^{15}N were assigned $J^\pi = 3/2^{(-)}$. The transitions to the ground states practically cover the total $p^1/_2$-strengths in the three reactions. The $p^3/_2$-strength is considerably more split up. In the case of ^{16}O(d,^{3}He)^{15}N this is in contradiction to prevailing assumptions. In ^{15}N and ^{14}C the lowest $p^3/_2$-hole-states are separated from the $p^1/_2$-states by more than 6 MeV. The number of protons in $2s^1/_2$- and $1d^5/_2$-states is very small for ^{15}N and increases to about 0.5 for ^{18}O. A $1d^3/_2$-strength was not found for any of the investigated nuclei. In general the shell model calculations describe the experimental data very well. Only the 1 = 0-strength in ^{16}O and the $p^3/_2$-splitting in ^{14}C are too small. The negative parity states in ^{17}N show a rotational structure and are well described by calculations without core excitation. For all three target nuclei the separation energies and the binding energies of the proton shells are indicated. There are systematic deviations between the measured angular correlations and the DWBA-calculations especially for the $p^1/_2$-particles in the cross section and for the 1 = 0- and 1 =2-particles in the shape of the distributions. (auth)

13958 (LA-4765) USE OF THE ^{7}Li(^{7}Li,2p)^{12}Be REACTION TO MEASURE THE GROUND STATE MASS OF ^{12}Be. Howard, Hillard H. (Los Alamos Scientific Lab., N. Mex.). Dec 1971. Contract W-7405-eng-36. 88p. Dep. NTIS.

The first experimental determination of the ^{12}Be ground state mass through use of the ^{7}Li(^{7}Li,2p)^{12}Be reaction in a kinematically complete experiment is reported. In order to perform a kinematically complete experiment using a three-body final state reaction, the momenta of two of the three final state particles must be measured in coincidence. The kinematical relation between these momenta allows the identification of the event as coming from a particular reaction with a particular Q-value. In the case of this experiment the detected particles are protons and their energies are measured by two detector telescopes whose positions relative to the target nucleus and the projectile momentum determine the angular factors of the protons' momenta. The Q-value of the reaction producing the two coincident protons can be calculated from the momenta and the masses of the reaction constituents. The mass excess of ^{12}Be determined in the above manner using the ^{7}Li(^{7}Li,2p)^{12}Be reaction is 24.95 ± 0.10 MeV. An excited state of ^{12}B is identified at an excitation energy of 0.81 ± 0.10 MeV. The impact of this determination on predictions of particle stability and mass systematics of light nuclei is discussed. (auth)

13959 (LBL-500, pp 267-9) MEASUREMENT OF THE SPIN-DEPENDENT PART OF THE SCATTERING AMPLITUDE OF SLOW NEUTRONS ON ^{19}F USING A POLARIZED BEAM AND A POLARIZED TARGET. Abragam, A.; Bachella, G. L.; Long, C.; Meriel, P.; Piesvaux, J.; Pinot, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The spin-dependent part of the scattering amplitude of slow neutrons on ^{19}F was measured using a polarized target of CaF_2. A value $\beta = a_+ - a_- = (-0.0135 \pm 0.002) \times 10^{-12}$ cm is found, one-tenth as large as a recent theoretical estimate. A control experiment measuring $\beta = a_+ - a_-$ for the proton by Bragg scattering on a single crystal of LiH yields the correct value within experimental error. (auth)

13960 (LYCEN-7133) STUDY OF CERTAIN EXCITED LEVELS OF ^{15}N USING THE ^{14}N(d,p)^{15}N REACTION. Bersillon, Olivier (Lyon Univ. (France). Institut de Physique Nucleaire). Jun 1971. 67p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The spin and parity of certain excited levels of ^{15}N were determined by studying the angular distributions of proton groups emitted in the ^{14}N(d,p)^{15}N reaction at 3.6 MeV. A gas target and a differential pumping system were used in order to avoid contamination. The results obtained concern the following levels: 9.762, 9.832, 9.929, 10.070, 10.452, 10.548, 10.710, and 10.815 MeV. They were compared with predictions from the DWBA theory. (France)

13961 ELASTIC SCATTERING OF FAST ELECTRONS BY ^{14}N. Banerji, G. (Indian Association for the Cultivation of Science, Calcutta). Indian J. Phys.; 44: No. 5, 319-22(May 1970).

The Born approximation is used with a parabolic potential to calculate the nuclear form factor for ^{14}N and to obtain the differential electron elastic scattering cross section. (R.W.R.)

13962 THEORY OF POLARIZED THERMAL NEUTRON SCATTERING ON ^{19}F. I. Gillet, V.; Normand, J. M. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Phys.; A176: No. 2, 225-36(1971).

Spin–spin amplitudes of thermal neutron scattering by ^{19}F are calculated in the framework of the microscopic shell model with two-body central forces. It is shown that limited information on the nature of nucleon–nucleon exchange forces can be extracted from such a theoretical analysis of the data. The ratio of the spin–spin amplitude to the spin-independent one is predicted to be negative; the experimental cross sections are accounted for, within the large present experimental errors. (auth)

13963 SPIN–SPIN DETERMINATIONS OF ^{10}B LEVELS BY $^{11}B(^3He,\alpha)^{10}B(\alpha_0)^6Li$ CORRELATIONS. Young, F. C.; Lindgren, R. A.; Reichart, W. (Univ. of Maryland, College Park). Nucl. Phys.; A176: No. 2, 289-98(1971).

Particle–particle correlations were measured for the $^{11}B(^3He,\alpha)^{10}B(\alpha_0)^6Li$ reaction proceeding through excited states of ^{10}B at 5.92, 6.03, 6.13, 6.57, and 7.00 MeV. A collinear geometry was used for the measurements to align the magnetic substates of the recoil ^{10}B nuclei to facilitate spin–parity determinations. The correlations for the 5.92-, and 6.03-MeV levels are consistent with the accepted 2^+ and 4^+ assignments for these levels. A definite assignment of 3^- is obtained for the 6.13-MeV level. Substantial interference between levels of opposite parity is observed for correlations of α-particle groups corresponding to the 6.57- and 7.00-MeV levels. This interference is accountable in terms of overlapping levels for assignments of 3^+ for the 7.00-MeV level and $(3,4)^-$ for the 6.57-MeV level. Only a 4^- assignment for the 6.57-MeV level is consistent with the present experiment and analyses of α-particle elastic scattering measurements. (auth)

13964 PYGMY RESONANCE IN THE $^{13}C(\gamma,n)^{12}C$ REACTION. Fukuda, K.; Okabe, S.; Sato, Y. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 75-82(1970).

The cross section for the reaction $^{13}C(\gamma,n)^{12}C$ was measured from threshold to 14 MeV using bremsstrahlung from a linear electron accelerator. The cross-section curve shows peaks at about 6.2(small), 7.5(shoulder), 8.2, 9.1, 11(shoulder) and 13 MeV, the last two being in the pygmy resonance. Neutrons from the peaks at 7.5 and 8.2 MeV follows a $1 + 1.5 \sin^2\theta$ angular distribution. These peaks are estimated mainly due to the $^3/_2^+$ levels in ^{13}C. The integrated cross sections of these peaks are 0.3 and 0.6 MeV · mb, respectively. Neutrons from the peak at 9.1 MeV follow an isotropic distribution. The integrated cross section of the peak is 1.2 MeV · mb. The cross section integrated from 10 to 14 MeV is 14 MeV · mb. This value is in agreement with an earlier experimental one. The neutrons in the pygmy resonance follow a $1 + 0.46 \sin^2\theta$ angular distribution, while $1 + 1.5 \sin^2\theta$ is expected from a pure single-particle model. No significant variation of the anisotropy factor of the distribution function was found in the photon energies from 10 to 13 MeV. The angular distribution of neutrons from the pygmy resonance can be explained in terms of core($p_{3/2}$) and valence ($p_{1/2}$) nucleon excitations. The cross-section curve is explained as follows: The mixing of the excited core state to the ground and excited states in ^{13}C probably reduces the photoneutron cross sections calculated on the basis of the pure single-particle model in the energy region from the threshold to 10 MeV. The mixing enhances the cross sections in the pygmy resonance energy region. (auth)

13965 ELASTIC AND INELASTIC SCATTERING OF 30.4 MeV POLARISED PROTONS BY ^{12} ^{13}C, ^{16}O, and ^{54}Fe. Greaves, P. D.; Hnizdo, V.; Lowe, J.; Karban, O. (Univ. of Birmingham, Eng.). Nucl. Phys.; A179: No. 1, 1-22(1972).

Cross sections, polarizations and analyzing powers are presented for the elastic and inelastic scattering of 30.4 MeV polarized protons by ^{12}C(Q = 0.0, –4.44, –7.65, –9.64 MeV), ^{13}C(Q = 0.0, –3.09 MeV), ^{16}O(Q = 0.0, –8.87 MeV) and ^{54}Fe(Q = 0.0, –1.41 MeV). Conventional optical-model analyses of the elastic scattering are presented. The inelastic scattering data are analyzed using a microscopic model employing shell-model wave functions, together with an effective interaction; also, a macroscopic collective model is applied where appropriate. The effective interactions derived from the microscopic model show a qualitative similarity to one another, each resembling a Serber force with an enhanced spin-independent part and a strong, attractive tensor part. A calculation using an interaction derived from a realistic force is also given for certain transitions. Acceptable agreement is obtained for the ^{16}O and ^{13}C states but not for the ^{12}C 7.65 MeV state. (auth)

13966 $^{12}C(d,n_0)^{13}N$ REACTION FROM 3.6-MeV TO 12.0-MeV. Davis, J. R.; Din, G. U. (Australian National Univ., Canberra). Nucl. Phys.; A179: No. 1, 101-12(1972).

The excitation function for the reaction $^{12}C(d,n_0)^{13}N$ was measured at 0° in the energy range of 3.6 to 12.0 MeV deuteron bombarding energy. Angular distributions were measured at 7.0, 8.0, 9.0, 10.5 and 12.0 MeV deuteron bombarding energies. Cross sections are compared with the $^{12}C(d,p_0)^{13}C$ reaction. The yield curves for the neutron and proton groups show a strong similarity in shape. Different sets of deuteron and proton optical-model parameters were used in fitting the 8 MeV energy averaged angular distribution. (auth)

13967 NUCLEAR SPECTROSCOPY WITH HEAVY-ION INDUCED PROTON-TRANSFER REACTIONS IN LIGHT NUCLEI. Schlotthauer-Voos, Ursula C.; Bohlen, H. G.; Von Oertzen, W.; Bock, R. (Univ., Marburg, Ger. Max-Planck Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A180: No. 2, 385-401 (1972).

Angular distributions of the proton-transfer reactions $^{11}B(^{16}O,^{15}N)^{12}C$ at E_{lab} = 27, 30, 32.5, 35 and 60 MeV and $^{12}C(^{19}F,^{20}Ne)^{11}B$ at E_{lab} = 40, 60 and 68.8 MeV to ground and excited states of both final nuclei were measured. A DWBA analysis based on the method of Buttle and Goldfarb shows that a consistent description of all data is possible with those optical-model parameters, which are obtained from the analysis of the elastic scattering data by applying the concept of strong absorption. The relative spectroscopic factors are independent of energy and in good agreement with theoretical values and those obtained by conventional reactions. The absolute values agree within a factor 1.5 in the ^{16}O on ^{11}B case. (auth)

13968 DECAY OF ^{12}C VIA THE $^{11}B(p,2\alpha)\alpha$ REACTION. Von Witsch, W. (Rice Univ., Houston, Tex.); Ivanovich, M.; Rendic, D.; (and others). Nucl. Phys.; A180: No. 2, 402-16 (1972).

The $^{11}B(p,2\alpha)\alpha$ reaction has been studied in a kinematically complete experiment over a wide range of angles at bombarding energies corresponding to resonances in ^{12}C at E_x = 17.23 MeV, 17.77 MeV and 18.36 MeV. The coincidence spectra exhibit interference effects which can be reproduced theoretically if the identity of the three final-state particles is properly taken into account. A strong dependence of the cross section on the channel spin s and the angular momentum L in the 2α subsystem is demonstrated. Although no effort was made to produce best fits to the data, satisfactory overall agreement between theory and experiment could be obtained. The results of the calculations support the assignment $I^\pi = 3^-$ for the resonance in ^{12}C at E_x = 18.36 MeV. (auth)

13969 $^7Li(\alpha,n)^{10}B$ DIFFERENTIAL CROSS SECTION FOR α-ENERGIES OF UP TO 8 MeV. Van Der Zwan, L.; Geiger, K. W. (National Research Council, Ottawa). Nucl. Phys.; A180: No. 2, 615-24(1972).

Three neutron groups populating the 1.74 MeV, the 0.72 MeV and the ground state of ^{10}B were studied. The 0^0 differential cross section was determined in 0.1 MeV intervals for E_α = 4.8 to 7.9 MeV. Angular distributions for the n_0 group, populating the ground state of ^{10}B, were taken at fifteen α-energies and for the n_1 group at five energies. Neutron production cross sections derived from these distributions were compared to the well-known $^{10}B(n,\alpha_0)$ cross section, using the reciprocity theorem, and to the total yield as published by other authors. Except near the $^7Li(\alpha,n)$ threshold where the angular distribution is isotropic, all distributions show asymmetry about 90° and generally peak backwards. Compound-nucleus formation involving overlap of several resonances appears dominant for the emission of the ground state neutron group, whereas for the n_1 group certain evidence of the interference between compound-nucleus formation and direct reaction is seen. (auth)

13970 ISOSPIN PURITY OF THE 5.36 MeV STATE OF ^6Li. Cocke, C. L.; Adloff, J. C. (Institut de Recherches Nucleaires, Strasbourg). Nucl. Phys.; A172: No. 2, 417-25(1971).

The reaction $^7Li(^3He,\alpha)^6Li^*$(5.36 MeV) (d)^4He has been used to search for the isospin-forbidden decay of the 5.36 MeV, T = 1 state of ^6Li into α + d. An upper limit of 2% is placed on the deuteron branching ratio from this state, implying a reduced width for deuteron emission of less than 0.5% of the Wigner limit ($\hbar^2/mR^2$, with R = 3.7 fm). (auth)

13971 STUDY OF LOWEST EXCITED LEVELS OF ^{19}O BY MEASUREMENT OF ANGULAR CORRELATIONS AND MEAN

LIFETIMES. Hibou, F.; Fintz, P.; Rastegar, B.; Gallmann, A. (Laboratoire de Physique Nucleaire et d'Instrumentation Nucleaire, Strasbourg). Nucl. Phys.; A171: No. 3, 603-13(1971). (In French).

To study the lowest levels of ^{19}O, pγ angular correlations (method II) and lifetime measurements (DSAM), have been performed in the $^{18}O(d,p\gamma)^{19}O$ and $^{17}O(t,p\gamma)^{19}O$ reactions. Mixing ratios have also been obtained. Some probable values and some upper limits for the spins of 5 levels are given. The level scheme is compared with results of shell-model calculations. (auth)

13972 PHOTOMESON EFFECTS IN (γ,n) AND (γ,p) REACTIONS IN LIGHT NUCLEI. Friberg, B.; Andersson, G.; Forkman, B. (Univ. of Lund, Sweden. Lund Inst. of Tech., Sweden). Nucl. Phys.; A171: No. 3, 551-9(1971).

Yield curves have been determined for (γ,n) reactions in ^{14}N, ^{16}O, ^{19}F, and ^{31}P and for the (γ,p) reaction in ^{30}Si using bremsstrahlung with maximum energies between 100 and 800 MeV. Above 200 MeV there is a difference between the yields determined and those predicted from the giant resonance data and, at higher energies, the quasideuteron absorption process. From the difference, which is assumed to represent the (γ,n) or (γ,p) reaction via meson production, the number of nucleons that can contribute to the reaction is calculated. The results are in good agreement with simple shell-model considerations. (auth)

13973 INVESTIGATION OF THE MECHANISM OF τ-INDUCED FOUR-NUCLEON PICK-UP REACTIONS. Detraz, C.; Zafiratos, C. D.; Moss, C. E.; Zaidins, C. S. (Univ. of Colorado, Boulder). Nucl. Phys.; A177: No. 1, 258-72(1971).

The α-transfer character of the $(\tau,^7Be)$ reaction which is shown to be direct is examined in the light of two particular experimental features: (i) the variation of the cross section with the mass of the target nucleus, and (ii) the hindrance of $\Delta T \neq 0$ or $\Delta S \neq 0$ transitions. The experimental evidence indicates that the dominant mechanism in the $(\tau,^7Be)$ reaction to low-lying states is a direct α-transfer. However, the possibility of a mechanism in which the two protons and two neutrons transferred are in a T = 1 state is investigated through an experimental study of the analog process, the transfer of a ^4H-like fragment. The corresponding reaction, $(\tau,^7Li)$, is found to proceed through a direct mechanism at forward angles. It is concluded, for the $^{19}F(\tau,^7Be)^{15}N$ ground state transition, that the magnitude of the T = 1 transfer amplitude is approximately $\sqrt{0.2}$ times the total transition amplitude. A simple estimate of the $(\tau,^7Li)$ and $(\tau,^7Be)$ reaction strengths, D_0, suggests that 2p + 2n, T = 1 clustering in light and medium nuclei is less probable than T = 0 α-clustering by almost two orders of magnitude. (auth)

13974 ^{14}ND–^{15}NH MASS DIFFERENCE. Kerr, D. P.; Bainbridge, K. T. (Harvard Univ., Cambridge, Mass.). Can. J. Phys.; 49: 1950-1(15 Jul 1971).

The $^{14}ND - ^{15}NH$ mass difference was measured directly using three different mass doublets. The result is compared with other values obtained from mass spectrometric data and nuclear reaction data. (auth)(Canada)

13975 $^{16}O(\gamma,n)^{15}O^*$ AND $^{16}O(\gamma,p)^{15}N^*$ REACTIONS AT INTERMEDIATE ENERGIES. Adler, J.-O.; Andersson, G.; Forkman, B.; Jonsson, G. G.; Lindgren, K. (Univ. of Lund, Sweden. Lund Inst. of Tech., Sweden). Nucl. Phys.; A171: No. 3, 560-74(1971).

The yields of the reactions $^{16}O(\gamma,n)^{15}O^*$ and $^{16}O(\gamma,p)^{15}N^*$ have been measured as a function of maximum bremsstrahlung energy from 100 to 800 MeV in an in-beam experiment. The de-excitation γ-radiation from the first $\frac{1}{2}^-$ excited states in ^{15}O and ^{15}N was measured with a large Ge(Li) detector. Analysis of the yield curves shows that in this energy region only very few of the nucleons in the upper nuclear shells contribute to the cross section. (auth)

13976 NON-NORMAL PARITY STATES IN A = 14 AND 13 NUCLEI. II. INTERMEDIATE-ENERGY STATES. Jaeger, H. U.; Kissener, H. R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys.; A171: No. 3, 584-92(1971).

A shell-model calculation in the full space of $1\hbar\omega$ excitations with A particles in the oscillator levels 1s, 1p, 1d, 2s provides a unified description of the low-energy spectra of non-normal parity and the photo absorption cross sections for A = 14 and 13 nuclei, using Cohen–Kurath and Gillet interactions. Good agreement with experimental data is obtained. The structure of electric dipole resonances is discussed. (auth)

13977 LEVEL STRUCTURE OF ^{16}O AND THE REACTIONS $^{15}N(p,p')^{15}N^*$. Dracoulis, G. D.; Legge, G. J. F. (Univ. of Melbourne, Parkville, Australia). Nucl. Phys.; A177: No. 1, 241-57 (1971).

The level structure of ^{16}O from 20 to 23 MeV has been studied by the measurement of excitation functions for the reactions $^{15}N(p,p')$ $^{15}N^*$ in energy increments of 20 keV. An enriched ^{15}N gas target was used and the 5.271–5.299 MeV doublet of positive-parity states in ^{15}N was resolved by means of a magnetic spectrometer. Decay to the first excited state at 5.271 MeV was found to be the most strongly resonant channel. Nine states in ^{16}O, five of them new, have been identified. Their widths have been measured and limits have been placed on some of the spins. Elastic scattering data were also taken over selected energy ranges. Comparisons are made with other reactions over the giant E1 resonance region of ^{16}O. Alternative interpretations of the low-lying positive-parity states of ^{15}N are discussed in light of the data. (auth)

13978 POLARIZATION OF NEUTRONS IN n–^{12}C SCATTERING: A STANDARD FOR POLARIZATION STUDIES IN THE MeV REGION. Holt, R. J.; Firk, F. W. K.; Nath, R.; Schultz, H. L. (Yale Univ., New Haven). Phys. Rev. Lett.; 28: No. 2, 114-17 (10 Jan 1972).

The polarization of neutrons elastically scattered from ^{12}C at 50° was measured as a continuous function of energy between 2 and 5 MeV by using a neutron double-scattering technique. This measurement provides an absolute standard for polarization studies in this energy range. The intense pulsed yield of neutrons obtained from the first scatterer is shown to be a practicable source of polarized neutrons suitable for high-resolution experiments in the MeV region. (auth)

13979 NEGATIVE PI-MESON ABSORPTION FROM REST IN CARBON. Larson, Duane Allen. Auburn, Ala.; Auburn Univ. (1971). 50p. University Microfilms Order No. 72-2215.

Thesis.

One thousand interactions of negative pi mesons absorbed from rest by carbon nuclei were analyzed using Ilford K.2 emulsion to identify isotopes of hydrogen and helium and measure the energy of these particles. Of the 1669 secondary particles, 673 are identified as hydrogen nuclei, 791 as helium nuclei, and 205 as either helium nuclei or heavier fragments. The results are compared with values from an evaporation calculation by Guthire, Alsmiller, and Bertini and with an estimate by Fowler. The alpha-particle spectrum shows fair agreement with calculated values at low energies, but several high-energy alpha particles were found that are not predicted by evaporation theory. The proton spectrum agrees with the evaporation model only in the 5 to 12 MeV range. (Diss. Abstr. Int., B)

13980 $^{12}C(^{12}C,\alpha)^{20}Ne$: DIRECT REACTION WITH A DIFFERENCE. Noble, J. V. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 28: No. 2, 111-14(10 Jan 1972).

The simplest direct mechanism (pole diagram) for $^{12}C(^{12}C,\alpha)$ ^{20}Ne has about as much gross structure as the data; thus, the hypothesis of a compound or "doorway" mechanism is unnecessary. (auth)

13981 RADIATIVE PION CAPTURE BY ^{12}C. Lam, W.-C.; Gotow, K.; Macdonald, B.; Trower, W. P.; Anderson, D. K. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Phys. Rev. Lett.; 28: No. 2, 108-10(10 Jan 1972).

The neutron–photon angular-correlation and energy spectrum of neutrons from radiative pion capture by carbon are presented and provide new evidence for excitation of a $J^\pi = 1^-$ axial-vector collective mode. Asymmetry in the angular correlation increases with neutron energy and is accounted for by direct neutron emission. (auth)

13982 STUDY OF THE STATES IN ^{19}Ne VIA THE REACTION $^{20}Ne(^3He,^4He)^{19}Ne$. Haynes, Donald Stephen. Tallahassee; Florida State Univ. (1971). 113p. University Microfilms Order No. 72-269. 72-169.

Thesis.

Excitation energies of the states in ^{19}Ne are measured up to an energy of ≈10.6 MeV in ^{19}Ne. Fourteen of these values correspond to previously unreported states. The technique employed in the extraction of centroids of energy groups in the pulse height spectrum is described along with a detailed description of an energy spectrum line shape analysis. Angular distributions of ^4He particles from the reaction $^{20}Ne(^3He,^4He)^{19}Ne$ at the ^3He energy of 18 MeV are measured for transitions to the ground state and several excited states in ^{19}Ne. These angular distributions are analyzed with the conventional Distorted-Wave Born-Approximation. Relative spectroscopic factors are extracted and compared with the predictions of the spectroscopic factor sum rule. (Diss. Abstr. Int., B)

13983 ENERGY LEVELS OF ^{16}O BETWEEN 10.0 AND 17.1 MeV EXCITATION. Marvin, T. P.; Singh, P. P. (Indiana Univ., Bloomington). Nucl. Phys.; A180: No. 1, 282-310(1972).

A phase-shift analysis has been performed on $^{12}C(\alpha,\alpha_0)^{12}C$ cross sections which were measured over a broad angular range

from 4.0 to 13.3 MeV in 15 to 50 keV increments. In addition to confirming the presence and determining the J, π, Γ, Γ_α of the levels at 10.36, 11.50, 11.60, 12.47, 13.10, 13.11, 13.13, 13.25, 13.89, 14.07, 14.6, 14.82, 14.87, 15.47 and 16.30 MeV excitation in the ^{16}O compound system, the results include the observation of a new 0^+ level at 15.17 MeV. Definite J^π values of 4^+, 5^- and 3^- have been assigned for the levels at 14.6, 14.82 and 15.47 MeV respectively. Refined level parameters are given for the 0^+ (14.07 MeV) and 6^+ (14.87 MeV) levels. (auth)

13984 OBSERVATION OF α-PARTICLE CORE-EXCITED THRESHOLD STATES IN LIGHT NUCLEI. Weller, H. R. (Univ. of Florida, Gainesville). Phys. Rev. Lett.; 28: No. 4, 247-9 (24 Jan 1972).

The nuclei ^{15}N, ^{15}O, and ^{19}Ne are examined in terms of the appearance of α-particle core-excited threshold states. It is shown that this simple model can account for most of the α-particle states seen above the threshold for α-particle emission. The most striking features of these states are discussed. (auth)

13985 REACTION $^{14}N(^{14}N,\alpha)^{24}Mg$ AT 20.2 AND 28.0 MeV. Middleton, R.; Garrett, J. D.; Fortune, H. T. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 4: No. 6, 1987-91(Dec 1971).

The reaction $^{14}N(^{14}N,\alpha)^{24}Mg$ has been studied at bombarding energies of 20.2 and 28.0 MeV. Differential cross sections at forward angles were only 0.01 to 0.02 mb/sr for the strongest transitions. It was impossible to identify transitions to the high-spin states that were observed to be selectively populated in recent $^{16}O(^{12}C,\alpha)^{24}Mg$ and $^{12}C(^{16}O,\alpha)^{24}Mg$ studies. (auth)

13986 NON-NORMAL-PARITY STATES IN ^{19}F. Lee, T. Y.; Chen-tsai, C. T.; Yeh, W. W.; Hsieh, S. T. (Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., C; 4: No. 6, 1991-4(Dec 1971).

Using the non-central particle-hole interaction determined from a fit of the energy spectra of the non-normal-parity states in ^{15}O, ^{16}O, and ^{17}O, the energy spectrum of the non-normal-parity states in ^{19}F was reproduced satisfactorily via a shell-model calculation. The important contribution from T = 1 states of ^{20}Ne coupled to a $1p_{\frac{1}{2}}$ hole in the ^{19}F wave functions is pointed out. (auth)

13987 SPECTROSCOPIC FACTORS FOR T = $\frac{3}{2}$ STATES IN A = 19 NUCLEI. Fortune, H. T. (Univ. of Pennsylvania, Philadelphia. Argonne National Lab., Ill.); Vincent, C. M. Phys. Rev., C; 4: No. 6, 1994-7(Dec 1971).

Distorted-wave calculations have been performed for the reaction $^{18}O(d,p)^{19}O$ to the $\frac{5}{2}^+$ ground state and the $\frac{1}{2}^+$ state at 1.467 MeV in ^{19}O, as well as for the reaction $^{18}O(^3He,d)^{19}F$ leading to the analogs of these states—the (bound) $\frac{5}{2}^+$ state at 7.540 MeV and the (unbound) $\frac{1}{2}^+$ state at 8.795 MeV in ^{19}F. The resulting spectroscopic factors are in good agreement with each other, although previous work had suggested a discrepancy. However, the spectroscopic factors are only about half as large as the shell-model predictions. (auth)

13988 CLUSTERING CHARACTERISTICS OF ^6Li FROM THE $^6Li(\alpha,\alpha\chi)Y$ REACTION AT E_α = 50 MeV. Lambert, J. M.; Kane, R. J.; Treado, P. A.; (and others) Phys. Rev., C; 4: No. 6, 2010-19(Dec 1971).

The quasielastic scattering of 50-MeV α particles has been used as a tool to study the cluster configurations of the ^6Li nucleus by means of the $^6Li(\alpha,\alpha\chi)Y$ reaction. Data have been obtained in kinematically complete experiments and at exact quasielastic angles for those cases corresponding to χ = p, d, t, ^3He, and α. Analysis has been carried out in the framework of the plane-wave impulse approximation. Quasielastic cross sections have been measured and experimental momentum distributions extracted. Theoretical fits to these distributions using simple Gaussian and exponential functions have been calculated and used to determine both absolute and relative clustering probabilities with fair success. The more reliable relative probabilities indicate strong p, d, and α clustering in ^6Li and rather weak t and ^3He clustering. (auth)

13989 NEUTRON TOTAL CROSS SECTIONS OF THE LIGHT ELEMENTS IN THE ENERGY RANGE 24 TO 60 MeV. Auman, M.; Brady, F. P.; Jungerman, J. A.; (and others) (Univ. of California, Davis). Phys. Rev., C; 5: No. 1, 1-5(Jan 1972).

The neutron total cross sections of natural Be, C, N, O, Mg, Al, and Si were measured at a number of energies between 24 and 60 MeV. The over-all precision is better than 1%, and the energies were determined to 100 keV. Smooth variations of the cross sections with energy are found. (auth)

13990 REACTION $^{20}Ne(^3He,\alpha)^{19}Ne$ AT 18 MeV. Haynes, D. S.; Kemper, K. W.; Fletcher, N. R. (Florida State Univ., Tallahassee). Phys. Rev., C; 5: No. 1, 5-12(Jan 1972).

Excitation energies of the states in ^{19}Ne were measured via the reaction $^{20}Ne(^3He,\alpha)^{19}Ne$ up to an excitation of ~10.6 MeV. Angular distributions for several states were measured and analyzed by use of the conventional distorted-wave Born approximation. Relative spectroscopic factors were extracted and compared with the predictions of the spectroscopic-factor sum rule. The analysis fails to confirm an assignment of j = $\frac{3}{2}$ for the excited states at 6.01 and 6.74 MeV. (auth)

13991 HALF-LIFE OF ^{14}O. Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 5: No. 1, 274-5 (Jan 1972).

The half-life of ^{14}O is measured as 70.48 ± 0.15 s, in agreement with a recently reported value. The error assigned to the present result is thought to include a realistic assessment of the systematic errors in the measurement and analysis. (auth)

13992 PREDICTIONS OF DIFFERENTIAL CROSS SECTIONS FOR THE REACTIONS $^{10}B(n,\alpha_0)^7Li$ AND $^{10}B(n,\alpha_1)^7Li(0.48\ MeV)$. Hausladen, S. L. (Ohio Univ., Athens); Lane, R. O.; Monahan, J. E. Phys. Rev., C; 5: No. 1, 277-80(Jan 1972).

Differential cross sections for α particles to the ground and first excited states of ^7Li in the reaction $^{10}B(n,\alpha)^7Li$ were calculated from R-matrix parameters that fit neutron elastic scattering, neutron polarization, and $^{10}B(n,\alpha)^7Li$ reaction data. It is pointed out that a measurement of these α-particle angular distributions could resolve some of the ambiguities that remain in the interpretation of the $^{10}B(n,\alpha)^7Li$ reaction for neutron energies below 1 MeV. (auth)

13993 MULTILEVEL MULTICHANNEL STUDY OF THE STRUCTURE OF ^{15}N FROM 12- TO 14-MeV EXCITATION ENERGY. Ramirez, J. J.; Blue, R. A.; Weller, H. R. (Univ. of Florida, Gainesville). Phys. Rev., C; 5: No. 1, 17-29(Jan 1972).

Measurements of the cross sections for the reactions $^{14}C(p,p)^{14}C$, $^{14}C(p,\alpha_0)^{11}B$, $^{14}C(p,n_0)^{14}N$, $^{14}C(p,n_1)^{14}N$, $^{14}C(p,\gamma_0)^{15}N$, and $^{11}B(\alpha,\alpha)^{11}B$ were made for incident particle energies of 2 to 4 MeV. Preliminary Legendre-polynomial analyses of measured angular distributions were used to guide a multilevel multichannel R-matrix analysis. In the R-matrix formulation a set of level parameters for eight resonances was found which can account for the observed cross sections in all of the channels. The level at E_x = 13.42 MeV in ^{15}N was identified as the isobaric analog of the second excited state in ^{15}C. The reduced widths of this level in the various channels indicate that it contains at least a 10% admixture of T = $\frac{1}{2}$. A series of strong α-particle levels was found which fit into the α-particle core-excited threshold-state model scheme for ^{15}N. (auth)

13994 COULOMB ENERGY SHIFTS IN THE A = 18 NUCLEI. Kahana, S. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 5: No. 1, 63-75(Jan 1972).

The energies of the lowest five T = 1 states in ^{18}F and ^{18}Ne are predicted on the basis of a calculation using a realistic force tuned to fit the ^{18}O members of the same multiplets and including the known Coulomb interactions between protons. The nucleons are permitted to be in the $1d_{\frac{5}{2}}$ and $2s_{\frac{1}{2}}$ levels, the latter being described by Woods–Saxon wave functions. Particle–particle, hole–particle, and hole–hole corrections are included. Reasonable agreement with experiment is obtained for all but the excited 0^+ multiplet. It is necessary to introduce a small (short-range and attractive) charge-dependent force to explain the ^{18}F data. (auth)

13995 BRUECKNER–HARTREE–FOCK CALCULATIONS USING DENSITY-DEPENDENT EFFECTIVE INTERACTION APPLICATION TO DEFORMED NUCLEI ^{12}C AND ^{20}Ne. Reid, Neal E. (Univ. of Maryland, College Park. Univ. of Manitoba, Winnipeg); Stephenson, G. J. Jr.; Banerjee, Manoj K. Phys. Rev., C; 5: No. 1, 287-94(Jan 1972).

A Brueckner–Hartree–Fock calculation of the deformed nuclei ^{12}C and ^{20}Ne becomes possible with the use of a density-dependent effective interaction to produce effective G matrix elements. An average-density approximation is employed. The inclusion of the rearrangement energy in the calculation leads to an improved estimate of the binding energies. The calculation is done in the matrix representation with deformed Cartesian oscillator functions as a basis. The effects of mixing deformed major shells are compared with the mixing implicit in the Nilsson model. (auth)

13996 BRUECKNER–HARTREE–FOCK CALCULATIONS USING DENSITY-DEPENDENT EFFECTIVE INTERACTIONS. APPLICATION TO ^{16}O. Reid, Neal E.; Banerjee, Manoj K.; Stephenson, G. J. Jr. (Univ. of Maryland, College Park). Phys. Rev., C; 5: No. 1, 41-53(Jan 1972).

The effects of allowing variations in the radial orbital wave functions, or major shell mixing, are investigated within the framework of Brueckner–Hartree–Fock (BHF) theory for ^{16}O.

The calculation is carried out in the matrix representation using harmonic-oscillator wave functions as a basis. Effective G-matrix elements are calculated through the use of a density-dependent, two-body operator following a prescription of Bethe. Two possible parametrizations, the local-density approximation and an average-density approximation, are compared. Consideration of the rearrangement energy shows that it is an important contribution to the binding energy. The problem is formulated in a way which facilitates the application of BHF theory to deformed as well as spherical nuclei. (auth)

13997 SEPARATION METHOD FOR ^{18}O USING ONE-BOSON-EXCHANGE POTENTIALS. Ganas, P. S. (California State Coll., Los Angeles). Phys. Rev., C; 5: No. 1, 36-41(Jan 1972).

Realistic, generalized, and regularized velocity-dependent one-boson-exchange-potential models of the nucleon–nucleon interaction are applied to calculate the low-lying energy levels of the nucleus ^{18}O in the harmonic-oscillator shell model. The singlet even states are treated by the Moszkowski–Scott separation method technique. The energy levels so obtained are comparable to those obtained from the phenomenological Hamada–Johnston hard-core potential. Core-polarization effects are not calculated explicitly, but rather simulated by varying the coupling constant of the light scalar meson. (auth)

13998 STUDY OF FINAL STATE PROTON–PROTON INTERACTIONS AND THE $^{28}Si(^3He,2p)$ AND $^{12}C(^3He,2p)$ REACTIONS AT 40 MeV. Stupin, David Mitchell. Boulder, Colo.; Univ. of Colorado (1971). 190p. University Microfilms Order No. 71-25,876. Thesis.

Kinematically complete two-detector coincidence experiments have been performed in which (1) the angular distributions of the cross sections and (2) the proton-proton relative energy distributions of the triple differential cross sections $d^3\sigma/d\Omega_1 d\Omega_2 dT_1$ were measured for $^{12}C(^3He,2p)$ and $^{28}Si(^3He,2p)$ reactions. Five states in ^{29}Si and two states in ^{13}C were studied at an incident ^3He energy of 40 MeV. Angular distributions for the $(^3He,2p)$ cross sections were compared to corresponding measurements for $(^3He,d)$ reactions and to angular distributions predicted by distorted wave calculations. The shapes of the $(^3He,2p)$ and $(^3He,d)$ distributions are similar, and distorted wave calculation predictions which use deuteron optical potentials are reasonable representations of the $(^3He,2p)$ data. In order to measure the proton-proton final state interaction, the data were compared to a $(^3He,2p)$ reaction theory. Strong enhancements due to final state proton-proton interactions were observed, and the possibility of extracting a proton-proton scattering length was explored. (Diss. Abstr. Int., B)

13999 DOUBLE LEVEL AT 8.92 MeV IN ^{15}O. Lambert, M.; Bersillon, O.; Chambon, B.; Drain, D.; Vidal, J. L. (Univ. Claude Bernard de Lyon, Villeurbanne, France). Lett. Nuovo Cim.; 2: No. 23, 1193-8(4 Dec 1971). (In French).

Excitation functions for proton elastic scattering by ^{14}N were measured between 1.7 and 1.8 MeV for nine angles. The results indicate that the level at 8.920 MeV in ^{15}O is really a doublet with widths of 3.5 and 9 keV and spin–parity assignments of $5/2^+$ and $1/2^-$, respectively. (3 figures, 2 tables) (R.W.R.)

14000 MANY-PARTICLE EXCITED STATES IN NUCLEI. Grin, Yu. T.; Leinson, L. B. (Inst. of Atomic Energy, Kiev). Phys. Lett.; 37B: No. 3, 253-6(29 Nov 1971).

Energies, quadrupole moments and shapes of many-particle excited states in ^{12}C and ^{16}O are calculated. The connection of the obtained results with the cluster model is discussed. (auth)

14001 NEW EVIDENCE FOR GROUND STATE DEFORMATION OF ^{16}O. Resmini, F.; Lombard, R. M.; Pignanelli, M.; Escudie, J. L.; Tarrats, A. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 37B: No. 3, 275-7(29 Nov 1971).

This letter reports the experimental results of (p,p') scattering, with polarized protons, on ^{16}O and the analysis for low-lying positive-parity states based on the rotational model. Values of $\beta_2 = 0.37 \pm 0.03$ and of $\beta_4 = 0.18 \pm 0.04$ are obtained. (auth)

14002 STRIPPING INTO UNBOUND STATES: INTERFERENCE BETWEEN RESONANT AND CONTINUUM STATES. Fuchs, H.; Homeyer, H.; Lorenz, Th.; Oeschler, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett.; 37B: No. 3, 285-7(29 Nov 1971).

Proton spectra from the $^{15}N(d,p)$ reaction leading to unbound states of ^{16}N are presented. A resonance at 5.05 MeV in ^{16}N interferes destructively with the continuum. The proton spectra look remarkably similar to the corresponding $^{15}N(n,n)$ total cross section. (auth)

14003 RESONATING GROUP FORMALISM OF THE CHARGE FORM FACTOR OF ^6Li. Chowdhury, S. M. M. R.; Afzal, S. A.; Suhrabuddin, S. (Dacca Univ., East Pakistan). J. Natur. Sci. Math.; 10: No. 2, 305-9(Oct 1970).

The charge form factor of ^6Li is calculated with a relative wave function of alpha and deuteron clusters, which is obtained numerically following a resonating-group method. The theoretical results obtained are compared with the experimental data and are found to be fairly satisfactory. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 12131, 13521, 13936, 13937, 13939, 13955, 13956, 13965, 13972, 13973, 13982, 13989, 13990, 13995, 13998, 14075, 14078, 14080, 14087, 14088, 14095, 14164, 14173, 14180, 14182, 14204, 14205, 14207, 14217–14219, 14221, 14239, and 14244.

14004 (INP-765) EXCITED STATES OF ^{79}Kr OBSERVED IN THE DECAY OF ^{79}Rb. Broda, R.; Rybicka, M.; Styczen, J.; Walus, W.; Krolas, K. (Institute of Nuclear Physics, Krakow (Poland)). Jul 1971. 32p. Dep. NTIS (U. S. Sales Only).

The level scheme of ^{79}Kr was investigated from the decay of 23.8-min ^{79}Rb. Using Ge(Li) detectors and scintillator NaI(Tl) counters single, prompt coincidence and delayed coincidence spectra were measured. For the 156.9-keV state the value of the lifetime of (79.1 ± 1.5) nsec was obtained, which is in good agreement with previous results, and for the 182-keV state the upper limit of 0.6 nsec. From the end-point energies of positron spectra in coincidence with prominent γ-rays the decay energy of (3726 ± 60) keV of ^{79}Rb was determined. The proposed level scheme of ^{79}Kr incorporates all the observed transitions except four weak ones. The log ft values (or their limits) were determined for β^+ transitions to the excited states of ^{79}Kr. The results are compared with previous work and differences in the spin assignments of some excited states of ^{79}Kr and of the ground state of ^{79}Rb are discussed. A comparison of the low-lying states of ^{79}Kr and ^{77}Se is made and a description of some excited states in the framework of the Nilsson model is also discussed. (auth)

14005 (JPRS-54305, pp 27-41) NUCLEAR TEMPERATURE AND INELASTIC STRAY NEUTRON SPECTRA FOR Cu, Fe, AND Nb. Sal'nikov, O. A.; Lovchikova, G. N.; Kotel'nikova, G. V.; Fetisov, N. I.; Trufanov, A. M. Translated from Byull. Tsentra Yadern. Dannym; No. 6, 189-211(1969).

Nuclear temperatures of Cu, Fe, and Nb as determined from the energy spectra of inelastic stray neutrons with an initial energy of 14.4 MeV are presented. The data are corrected for neutron attenuation and multiple scattering in the sample. The summed neutron energy spectra from (n,n') and (n,2n) reactions are also presented. (J.W.R.)

14006 (LBL-500, pp 329-40) NUCLEAR REACTIONS AND SCATTERING WITH POLARIZED BEAMS. Haeberli, W. (Wisconsin Univ., Madison). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Results of recent experiments with polarized protons and deuterons at the Wisconsin tandem accelerator are discussed. (auth)

14007 (LBL-500, pp 363-5) MEASUREMENT OF SPIN-CORRELATION PARAMETERS AT 47.5 MeV AT THE INS. Horikawa, N. (Nagoya Univ. (Japan)). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

A report on the measurement of the spin correlation parameters and a qualitative discussion of the results are presented. (auth)

14008 (RCN-152) CIRCULAR POLARIZATION OF GAMMA RAYS FROM CAPTURE OF POLARIZED THERMAL NEUTRONS. Stecher-Rasmussen, F. (Reactor Centrum Nederland, Petten). Jun 1971. 53p. Dep. NTIS (U. S. Sales Only).

Thesis.

The study of the circular polarization of γ-rays from capture of polarized thermal neutrons in Al, Ar, Ca, Co, Mn, Ni, Ga and W is described. The thermal neutrons are extracted from the High Flux Reactor in Petten and polarized by transmission through a focussing mirror system with magnetized mirrors. From the measurements of the circular polarization of γ-rays from capture of polarized thermal neutrons in natural Al, Ar and Ca new spin assignments to the following bound states are deduced: ^{28}Al (3.47 MeV), $J^\pi = 4^-$; $^{28}Al(3.59)$, $J^\pi = 4^-(2^-)$; $^{41}Ar(2.95)$, $J^\pi = 3/2^-$ and $^{41}Ca(4.78)$, $J^{\pi-} = 3/2$. The ^{41}Ca levels at 3.61 and 4.75 MeV,

for which conflicting spin values have been reported previously, both have $J^\pi = 1/2$. The spins of 10 other bound states are confirmed. The M1 + E2 ground-state transition from the capturing state in ^{28}Al has an amplitude mixing ratio of $\delta = +1.0 \pm 0.1$. The circular polarization of 15 primary γ-rays from the capture of polarized thermal neutrons in ^{59}Co was measured. Four new spins were assigned. The results are discussed in terms of single-particle states with superimposed proton core excitations. A possible connection between the neutron capture mechanism and the primary γ-ray spectrum is pointed out. Circular polarization measurements of the ^{59}Co(n,γ) reaction with polarized neutrons indicate the presence of a negative energy resonance with $J^\pi = 4^-$. It is shown that interference measurements on partial radiative capture can be explained without introducing potential capture. Capture gamma ray circular polarization measurements on the Mn(n,γ), Ni(n,γ), Ga(n,γ), and W(n,γ) reactions with polarized neutrons resulted in unambiguous spin assignments for 20 levels, 10 of which confirmed previous assignments. For another 20 levels the number of possible spin values was reduced. (auth)

14009 TRANSITION STRENGTHS IN ^{37}Ar AND ^{35}Cl. Caraca, J. M. G.; Gill, R. D.; Johnson, P. B.; Rose, H. J. (Oxford Univ.). Nucl. Phys.; A176: No. 2, 273-83(1971).

The decay modes and branching ratios of states in ^{37}Ar up to 3.60 MeV excitation energy were determined using the ^{37}Cl(p,n)^{37}Ar reaction. The existence of a new level at $E_x = 3184 \pm 3$ keV was confirmed. The decay of the 7/2, 3535-keV state was observed. By using the Doppler-shift attenuation method (DSAM), F values for some levels in ^{37}Ar and ^{35}Cl were measured by means of the reactions ^{37}Cl(p,n)^{37}Ar and ^{35}Cl(p,p')^{35}Cl*. The lifetimes deduced were $370 \pm {}^{190}_{110}$ fsec, 88 ± 24 fsec, and <8 fsec, for the 1409-, 2489-, and 2795-keV states in ^{37}Ar, respectively; and 83 ± 21 fsec and 11 ± 7 fsec for the 2646- and 2695-keV states in ^{35}Cl, respectively. The data provide further evidence that the commonly used stopping power theory is in error under certain circumstances. (auth)

14010 ANALYSIS OF ^{63,65}Cu(^{3}He,d)^{64,66}Zn REACTION IN THE UNIFIED MODEL. Abecasis, S. M. (IIAE, Buenos Aires); Krmpotic, F.; Plastino, A. Nuovo Cim.; 6A: No. 3, 365-70 (1 Dec 1971).

An analysis of the experimental spectroscopic factors involved in the ^{63,65}Cu(^{3}He,d)^{64,66}Zn reactions is proposed within the intermediate-coupling approach in the unified model. (auth)

14011 STUDY OF THE REACTIONS ^{20}Ne(d,α)^{18}F AND ^{22}Ne(d,α)^{20}F AT $E_d < 3.2$ MeV. Morand, C. (Institut d'Etudes Nucleaires, Algiers); Beaumevieille, H.; Dauchy, A.; (and others). Nuovo Cim.; 6A: No. 3, 380-92(1 Dec 1971). (In French).

Angular distributions and absolute cross sections for the ^{20}Ne(d,α)^{18}F and ^{22}Ne(d,α)^{20}F reactions were obtained at E_d = 2.0, 3.0, and 3.2 MeV. In addition, excitation functions were taken at some angles for the ^{20}Ne(d,α) reaction. An analysis of the data was made using the Hauser–Feshbach theory. (auth)

14012 DETERMINATION OF THE (n,n'γ) CROSS SECTIONS FOR 14.4-MeV NEUTRONS IN THE MASS REGION A = 46 TO 88. Bruenlich, W. (Institut fuer Radiumforschung und Kernphysik, Vienna); Stengel, G.; Vonach, H. Z. Naturforsch.; 26a: 451-7 (Mar 1971). (In German).

A systematic investigation of the (n,n'γ) cross sections for 14-MeV neutrons was carried out on even–even nuclei in the mass region A = 46 to 88. The cross sections for the excitation of the first 2^+ level were measured for 19 nuclei in this region. The results could be explained by the statistical model of nuclear reactions. (tr-auth)

14013 ^{86}Sr(d,p)^{87}Sr REACTION. Bucurescu, D. (Technische Hogeschool, Eindhoven, Netherlands); Spilling, P.; Ivascu, M. Rev. Roum. Phys.; 16: No. 6, 659-62(1971).

The ^{86}Sr(d,p)^{87}Sr reaction was studied at an incident energy of 8.0 MeV; 26 transitions to final states in ^{87}Sr were identified below 5.23 MeV. Differential cross sections were analyzed by the zero-range DWBA. Spin assignments, l_n's, and spectroscopic factors are tabulated for levels up to 3.32 MeV. Sum-rule strengths and single-particle energies calculated on the basis of the spectroscopic factors and excitation energies are given. (1 figure, 3 tables) (R.W.R.)

14014 OPTICAL-MODEL ANALYSIS OF ELASTIC SCATTERING AND POLARIZATION OF 30.5 MeV PROTONS FROM ^{64,66,68}Zn. Tait, W. H. (North East London Polytechnic); Burge, E. J.; Edwards, V. R. W. Nucl. Phys.; A176: No. 2, 390-400(1971).

Cross sections for proton elastic scattering from ^{64,66,68}Zn and the corresponding polarizations from ^{64,68}Zn were measured at 30.5 MeV and analyzed in terms of the regular optical model and the reformulated version of Greenlees and coworkers. (auth)

14015 STUDY OF THE LEVELS OF THE ^{32}S FORMED BY MEANS OF THE REACTION ^{28}Si(α,γ)^{32}S. Chevallier, A. (Centre de Recherches Nucleaires, Strasbourg); Bozek, E.; Pape, A.; (and others). Nucl Phys.; A176: No. 2, 401-12(1971).

Sixteen resonances were observed in the reaction ^{28}Si(α,γ)^{32}S in the range E_α = 4.2 to 6.0 MeV. Spins and parities were determined by angular-distribution and -correlation measurements. The lifetime of the 4.29-MeV level of ^{32}S was deduced from a Doppler-shift-attenuation measurement as $\tau_m = 94 \pm 30$ fs. The transition strengths, deduced from measured resonance strengths and branching ratios, exhibit the expected inhibition of dipole transitions in self-conjugate nuclei. (auth)

14016 DECAY OF ^{63}Zn. Sato, Yuji; Azuma, Toshio. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 83-8(1970).

The energies and relative intensities of the γ-rays following the radioactive decay of 38.1 min ^{63}Zn, produced by the ^{64}Zn(γ,n) reaction, were measured using a 40-cc Ge(Li) detector and a 4096-channel analyzer. γ-rays of 584-, 1150-, 1927-, 2186-keV, and doublets of 1862- and 1866-keV were newly measured. But the γ-rays of 1209.1-, 1340.0-, and 3101-keV could not be confirmed. A decay scheme of ^{63}Zn is recommended. (auth)

14017 CROSS SECTIONS OF ^{79}Br(n,α)^{76}As, ^{81}Br(n,α)^{78}As, AND ^{68}Zn(n,α)^{65}Ni REACTIONS INDUCED BY 13.6 TO 14.8 MeV NEUTRONS. Sato, Jun; Saito, Nobufusa; Yokoyama, Yuji (Tokyo Univ.). Radiochim. Acta; 16: No. 2, 71-4(Nov 1971).

Cross sections of ^{79}Br(n,α)^{76}As, ^{81}Br(n,α)^{78}As, and ^{68}Zn(n,α)^{65}Ni reactions induced by 13.6, 14.1, and 14.8 MeV neutrons have been determined by a radiochemical method. The (n,α) cross section values for 14 MeV neutrons of ^{79}Br, ^{81}Br, and ^{68}Zn were determined to be 10.0 ± 0.5 mb, 3.5 ± 0.5 mb, and 7.5 ± 0.5 mb, respectively. The cross section ratio of ^{79}Br to ^{81}Br was calculated to be 3 ± 0.5. (auth)

14018 LIFETIMES IN ^{43}Sc. Ball, G. C.; Forster, J. S.; Ingebretsen, F. (Chalk River Nuclear Labs., Ont.). Nucl. Phys.; A180: No. 2, 517-28(1972).

The Doppler-shift attenuation method has been used to measure the lifetimes of 17 excited states of ^{43}Sc and upper or lower limits for 8 others. The levels were populated by the ^{40}Ca (α,pγ)^{43}Sc reaction at several incident energies between 7.0 and 12.0 MeV using targets of calcium evaporated on thick gold backings as well as rolled Ca metal foils. Gamma rays were detected at angles between 0° and 120° using a 44 cm^3 Ge(Li) detector mounted inside a split annular NaI(Tl) crystal which was operated in an escape suppressed mode. Several weak γ-ray transitions were observed for the first time including the 1408 keV, $1/2^- \rightarrow$ 472 keV, $3/2^-$ (3 ± 1%) and 1651 keV, $5/2^+ \rightarrow$ 855 keV, $1/2^+$ (4 ± 2%) in-band transitions. Mean lifetimes (ps) were obtained for the following levels (keV) in ^{43}Sc: 845 (0.45 ± 0.08), 855 (>7.0), 880 ($5.8^{+1.9}_{-1.5}$), 1159 ($5.0^{+2.0}_{-1.2}$), 1179 (0.85 ± 0.14), 1336 (2.0 ± 0.4), 1408 (0.39 ± 0.07), 1651 (0.23 ± 0.05), 1811 (<0.08), 1830 (0.37 ± 0.07), 1883 (0.08 ± 0.03), 1931 (3.4 ± 0.8), 1963 (<0.12), 2094 (0.46 ± 0.13), 2106 (0.40 ± 0.08), 2141 (0.34 ± 0.14), 2143 (0.43 ± 0.16), 2289 (<0.03), 2336 (<0.06), 2459 (<0.06), 2552 (0.74 ± 0.10), 2635 (0.30 ± 0.10), 2760 (<0.07), 2810 (<0.12), and 2984 (0.09 ± 0.04). The transition strengths determined from these data for both positive- and negative-parity levels in ^{43}Sc are in reasonable agreement with the theoretical predictions of Johnstone. (auth)

14019 COLLECTIVE PROPERTIES OF ^{49}Cr. Zurmuehle, R. W.; Hutcheon, D. A.; Weaver, J. J. (Nuclear Physics Lab., Oxford). Nucl. Phys.; A180: No. 2, 417-33(1972).

The mean lifetimes of levels below 3 MeV excitation in ^{49}Cr were measured using the reaction ^{46}Ti(α,nγ)^{49}Cr. The Doppler-shift attenuation method was used in a neutron-gamma coincidence measurement. The lifetime of the first excited state was determined with the recoil distance method. The results are: 272 keV, 19 ± 5 ps; 1085 keV, 260 ± 90 fs; 1563 keV, 590^{+300}_{-120} fs; 1704 keV, >5.5 ps; 1742 keV, >4 ps; 1982 keV, >6.5 ps; 2169 keV, >4.5 ps; 2433 keV, >6 ps; 2504 keV, <12 fs; 2614 keV, 65 ± 20 fs. The lifetimes of the second and third excited states in combination with known multipole mixing ratios gave evidence for spin assignments of $9/2^-$ for the 1085 keV level and $11/2^-$ for the 1563 keV level. The energies and spins of the four lowest levels as well as the B(M1) and B(E2) values of their γ decays are in good agreement with calculations based on the strong coupling model and suggest that these levels are strongly collective. Dipole transitions of the higher levels to the ground and first excited states are highly retarded. (auth)

14020 DECAY OF ^{76}As. Morcos, N. A.; Ward, T. E.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Nucl. Phys.; A171: No. 3, 647-59(1971).

The decay of ^{76}As was studied using a Ge(Li) spectrometer and scintillation detectors. Sixty-three γ-rays were assigned to ^{76}As

and several coincidence measurements were performed. A decay scheme incorporating 51 of the γ-rays is tentatively proposed. From singles β-spectra and βγ coincidence measurements a β^- decay Q-value of 2.99 ± 0.08 MeV was determined. Levels in ^{76}Se were established at energies in keV of: 559.47, 1113.92, 1216.19, 1331.64, 1689.35, 1779.76, 1788.88, 2126.63, 2430.25, 2443.70, 2454.50, 2656.72, 2670.46. Spin-parity assignments were deduced for several levels. Evidence was found for the electron-capture decay of ^{76}As into ^{76}Ge. (auth)

14021 GAMMA SPECTRA FROM THE REACTION ^{54}Cr(n,γ)^{55}Cr. Bogdanov, A. P.; Soroka, A. V. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 4, 126-8 (1971). (In Russian)

The gamma radiation arising from the thermal neutron capture by ^{54}Cr nuclei was studied with a gamma spectrometer with a Ge(Li) detector. The gamma transition scheme of the ^{55}Cr nucleus from its primary state in the (n,γ) reaction is presented. A correlation was observed between the probabilities of excitation of the lower p-level of the ^{55}Cr nucleus in the reactions (n,γ) and (d,p). (tr-auth)

14022 ANGULAR MOMENTUM PROJECTION FROM NON-AXIAL INTRINSIC STATES: CALCULATIONS FOR ^{24}Mg. Watt, A. (Univ. of Glasgow). Nucl. Phys.; A172: No. 2, 260-72 (1971).

States of definite angular momentum projected from several HF solutions of ^{24}Mg are used as a basis in which to diagonalize the Hamiltonian. The results are compared with projection-before-variation calculations using non-axial intrinsic states. It is found that the realistic Kuo interaction gives good agreement with experiment and with recent exact shell-model calculations. (auth)

14023 COMPOUND NUCLEAR REACTION TIMES AND LEVEL DENSITIES FROM A BLOCKING EXPERIMENT IN Ge. Clark, G. J. (Atomic Energy Research Establishment, Harwell, Eng.); Poate, J. M.; Fuschini, E.; (and others). Nucl. Phys.; A173: No. 1, 73-91(1971).

The ⟨110⟩ axial blocking in Ge has been used to measure the ^{70}Ge(p,p')^{70}Ge* (1.04 MeV, 2$^+$) and ^{72}Ge(p,p')^{72}Ge* (0.835 MeV, 2$^+$) reaction times at 5.0, 5.4, and 6.0 MeV proton energy. A computer simulation was employed to extract the reaction times which were of the order 10^{-17} s with an accuracy of approximately 20%. The results are also analyzed in terms of the level densities and the relevant parameters for ^{71}As and ^{73}As extracted. (auth)

14024 SHELL-MODEL DATA FROM A REALISTIC N–N INTERACTION. II. NEGATIVE PARITY STATES IN ^{16}O AND ^{40}Ca. Irvine, J. M.; Pucknell, V. F. E. (Univ. of Manchester, Eng.). Nucl. Phys.; A173: No. 1, 129-40(1971).

Using interaction matrix elements and a single-particle representation obtained from a Brueckner–Hartree–Fock (BHF) calculation described in an earlier work (Nucl. Phys. A159: 513(1970)) (to be referred to as I), the negative-parity states of ^{16}O and ^{40}Ca are calculated in the particle-hole random phase approximation (RPA). In addition to the energies of the negative-parity states, the results of calculations of the ground state electric multipole transitions are also reported. (auth)

14025 PRELIMINARY EXPERIMENTS ON NUCLEAR REACTIONS INDUCED BY A Kr ION BEAM WITH AN ENERGY BETWEEN 450 AND 500 MeV, PRELIMINARY EVIDENCE IN FAVOR OF THE SYNTHESIS OF SUPERHEAVY NUCLEI. Bimbot, Rene; Deprun, Claude; Gardes, Daniel; (and others) (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 273: No. 12, 505-8(20 Sep 1971). (In French).

Several targets were bombarded with Kr^{23+} and Kr^{24+} ions with energies between 370 and 500 MeV. The formation of compound nuclei was studied for Ge and Cd targets. A critical value of 40 $\hbar/2\pi$ was determined for the angular momentum, which is in agreement with the results which have been obtained with Ar ions; α emitting nuclei were produced with Th targets; certain unknown energies were observed; the α emission between 13 and 15 MeV might correspond to short-lived superheavy elements. (France)

14026 (p,d) REACTIONS INDUCED BY A POLARIZED PROTON BEAM. Mayer, B. (CEN, Saclay, France); Gosset, J.; Escudie, J. L.; Kamitsubo, H. Nucl. Phys.; A177: No. 1, 205-40(1971).

Differential cross sections and asymmetries (or analyzing powers) have been measured for (p,d) reactions on $^{32-34}$S, ^{48}Ca, ^{49}Ti, ^{53}Cr, ^{57}Fe, $^{58-61}$Ni, $^{90-91}$Zr, ^{92}Mo, and $^{116-119}$Sn nuclei, with a polarized proton beam, at energies around 20 MeV. Experimental evidence is given for the strong j-dependence of the asymmetry, for the various orbital angular momenta transferred l = 1, 2, and 3, and therefore it is shown that asymmetry measurements in (p,d) reactions, such as in (d,p) reactions, provide reliable spin assignments. DWBA predictions with optical-model potentials obtained from analysis of the elastic scattering data in both proton and deuteron channels, give reasonable fits for the measured (p,d) cross sections and asymmetries, except for the light nuclei $^{32-34}$S. In case of transitions involving j-mixing, asymmetry measurements are used to determine the contributions of the different j-values. (auth)

14027 MEAN LIVES OF THREE ^{34}Cl LEVELS WITH THE RECOIL-DISTANCE METHOD. Barci, V.; Brandolini, F.; Signorini, C. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua. Laboratori Nazionali di Legnaro, Padua). Lett. Nuovo Cim.; 2: No. 17, 863-6(23 Oct 1971).

The recoil-distance method was used to determine the lifetimes of levels at 461, 666, and 1230 keV in ^{34}Cl; the levels were populated by means of the ^{31}P(α,n)^{34}Cl reaction. Gamma rays were detected with a resolution of 3 to 4 keV by using a Ge(Li) detector at 0°. Typical plunger spectra at different distances are given. The lifetimes for these levels were found to be 8.1 ± 0.9, 14.2 ± 1.5, and 22 ± 4 ps, respectively. (2 figures, 1 table). (R.W.R.)

14028 DE-EXCITATION OF THE ^{61}Cu COMPOUND NUCLEUS VIA PHOTON EMISSION FROM PROTON AND NEUTRON UNBOUND STATES. Hoffman, Edward J.; Sarantites, Demetrios G. (Washington Univ., St. Louis). Nucl. Phys.; A173: No. 1, 177-206(1971).

The relative yields to many levels in ^{61}Cu and ^{60}Ni populated via the ^{58}Ni(^{4}He,pγ)^{61}Cu and the ^{58}Ni(^{4}He,2pγ)^{60}Ni reactions were measured at 15.0, 18.0, 20.0, and 22.0 MeV of ^{4}He^{++} bombardment energies. The relative independent yields for the population of many individual levels in ^{61}Cu, defined to include all unobserved cascades, were measured as a function of excitation energy in the ^{61}Cu compound nucleus for each of the above bombardment energies. The experiment consisted of a two-parameter measurement of the γ-rays characteristic of ^{61}Cu or of ^{60}Ni observed in coincidence with protons of measured energy. The relative cross sections are found to peak at 3–7 MeV above the proton separation energy for many levels in ^{61}Cu. The reported results present direct evidence for photon emission from proton and neutron unbound states. The energy dependence of photon emission in competition with proton emission and with neutron emission at the higher bombardment energies is quantitatively determined for many levels in ^{61}Cu with known J^π values. The effect of the average angular momentum of the compound nucleus on the photon versus proton emission is reflected on the observed change of the integrated independent yields and on the position of the maximum of the independent yield curve with excitation energy for states of different J^π value when the bombardment energy is increased. The relative independent yields for the first six excited states in ^{60}Ni were also measured as a function of the observed proton energy in coincidence with the γ-ray de-exciting the level in question. The ratios of the integrated independent yields for many pairs of levels in ^{61}Cu and ^{60}Ni populated in the (^{4}He,pγ) and (^{4}He,2pγ) reactions were also obtained. The results of these experiments are consistent with the predictions of the compound statistical theory for nuclear reactions. The present results demonstrate that photon emission in competition with nucleon emission plays a dominant role in the outcome of reactions induced by ^{4}He^{++} for energies where multiple nucleon emission occurs. (auth)

14029 STRUCTURE OF ^{61}Cu VIA ^{58}Ni(^{4}He,pγ) HIGH-RESOLUTION PROMPT p-γ COINCIDENCE SPECTROMETRY. Hoffman, E. J.; Sarantites, D. G.; Lu, N.-H. (Washington Univ., St. Louis). Nucl. Phys.; A173: No. 1, 146-76(1971).

The level structure and the detailed decay properties of the levels in ^{61}Cu have been studied via prompt γ-ray energy and intensity measurements utilizing a NaI(Tl)-Ge(Li) anti-Compton spectrometer and pγ prompt coincidence techniques via the ^{58}Ni(^{4}He,pγ)^{61}Cu reaction with ^{4}He^{++} energies in the range 4.6 to 12.5 MeV. Many of the γ-rays associated with levels in ^{61}Cu were identified with the (^{4}He,pγ) reaction by means of extensive on-beam pγ coincidence measurements employing a 41 cm^3 Ge(Li) γ-ray detector and several annular Si(Li) or surface-barrier charged-particle detectors. Characterization of many levels in ^{61}Cu was aided considerably by a high-resolution study of the proton spectrum from the ^{58}Ni(^{4}He,p) reaction employing a tandem Van de Graaff accelerator and a split-pole Enge magnetic spectrograph. It was thus established that 50 levels up to 4.0 MeV in excitation are populated by this reaction in ^{61}Cu and that these accommodate 98 γ-rays. Branching ratios for the γ-de-excitation of 48 levels in ^{61}Cu were obtained by averaging the measured angular correlation of each γ-ray about the beam direction. The directional correlation of 18 primary γ-rays in coincidence with protons detected at approximately 180° with respect to the beam direction was measured and the results were used to assign definite J-values for many levels in ^{61}Cu. A detailed level scheme for the de-excitation of levels in ^{61}Cu is offered. (auth)

14030 STUDY OF THE 3.487 MeV 1^+ STATE IN ^{88}Sr. Metzger, F. R. (Franklin Inst., Swarthmore, Pa.). Nucl. Phys.; A173: No. 1, 141-5(1971).

The resonant scattering of bremsstrahlung γ-rays by the 3.487 MeV level in ^{88}Sr has been observed using a Ge(Li) detector. The angular distribution of the resonance radiation was found to be compatible only with the assignment of spin 1 to this state. A self-absorption study led to a value $\Gamma_0 = 0.150 \pm 0.024$ eV for the partial width of the ground state transition. This is approximately one-half the value predicted by shell-model calculations. The reduction in the M1 strength is attributed to the admixture of small components originating from the coupling of two proton holes to the giant M1 resonance in ^{90}Zr. (auth)

14031 MULTIPOLE MIXING OF SELECTED γ-TRANSITIONS IN ^{56}Fe. Taylor, H. W.; Singh, B. (Univ. of Toronto). Nucl. Phys.; A172: No. 2, 337-47(1971).

A NaI(Tl)-Ge(Li) directional-correlation spectrometer has been used to measure the multipole mixing ratio, δ, of the 977.46, 1037.91, 1360.22, 1771.41, 2034.92, 2598.58, 3202.30, 3253.62 keV γ-transitions in ^{56}Fe, which are excited by the decay of 77 d ^{56}Co. (auth)

14032 LIFETIME MEASUREMENTS IN ^{40}K. James, A. N.; Alderson, P. R.; Bailey, D. C.; (and others). (Univ. of Liverpool). Nucl. Phys.; A172: No. 2, 401-16(1971).

The Doppler-shift attenuation method has been used to measure the lifetimes of 19 levels in ^{40}K and four levels in ^{40}Ar. Limits have have also been set on the lifetimes of other levels in ^{40}K. The measurements were made using the ^{37}Cl(α,n)^{40}K and ^{37}Cl(α,p)^{40}Ar reactions. Enriched targets of lead chloride and barium chloride were used. The lifetimes obtained with different stopping materials and different recoil velocities were compared where possible and were found to be consistent. A γγ coincidence experiment was performed to elucidate the decay schemes in ^{40}K and ^{40}Ar. The negative-parity states of ^{40}K have γ-ray decay schemes consistent with simple shell-model calculations for $d_{\frac{3}{2}}-{}^1f_{\frac{7}{2}}$ and $d_{\frac{3}{2}}-{}^1p_{\frac{3}{2}}$ configurations. More information is needed before the 2p-2h and 4p-4h positive-parity states can be classified. (auth)

14033 MEASUREMENT OF MEAN LIFETIMES IN THE ^{61}Cu NUCLEUS. Heusch, B.; Cujec, B.; Dayras, R. (Univ. Laval, Quebec). Nucl. Phys.; A172: No. 2, 395-400(1971). (In French).

Lifetimes for the first ten excited states of ^{61}Cu have been measured by the Doppler-shift attenuation method. Gamma rays from the ^{58}Ni(α,pγ)^{61}Cu reaction were observed, in coincidence with protons, in a Ge(Li) detector at $\theta_\gamma = 130°$, 90°, 60°, and 0° at incident energy of 10.01 MeV. The radiative partial widths are obtained. (auth)

14034 INVESTIGATION OF THE EXCITED STATES OF ^{50}Mn AND OF ENERGY-DEPENDENT EFFECTS IN THE ^{50}Cr(^{3}He,t)^{50}Mn REACTION. Fadner, W. L.; Kraushaar, J. J.; Farwell, L. C. (Univ. of Colorado, Boulder). Nucl. Phys.; A178: No. 2, 385-409(1972).

Differential cross sections were measured for the ^{50}Cr(^{3}He,t)^{50}Mn reaction at 21.4, 29.7, and 37.5 MeV with an energy resolution of about 85 keV. Angular distributions were obtained for eight levels in ^{50}Mn ranging from the 0^+ ground state to 2.00 MeV excitation. The data were compared to both macroscopic and microscopic distorted-wave calculations, using a tensor force when appropriate. Several J, π assignments were made within two possibilities; 5^+, 6^+ ($E_x = 0.23$); 2^+, 1^+ (0.66); 1^+, 2^+ (0.81); 7^+ (1.03); and 3^+, 4^+ (1.15). Tentative assignments were 4^+, 3^+ (1.81) and 6^+, 5^+ (1.92). The resulting level scheme was compared to the levels of ^{48}V and to shell-model calculations. Significant discrepancies with this theoretical description were noted. Certain energy-dependent effects were also noted, in particular a marked decrease in interaction strength with increasing energy for all distorted wave models. These effects point out inadequacies in distorted wave calculations as they are presently made. (auth)

14035 IDENTIFICATION OF THE $4^+(d_{\frac{5}{2}})^{-2}$ STATE IN THE NUCLEUS OF ^{26}Al. Ronsin, Genevieve; Vergnes, Michel; Kalifa, Jacques; Rotbard, Georges (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 273: No. 15, 682-3(11 Oct 1971). (In French)

The levels of ^{26}Al were studied, using the (^{3}He,α) reaction. The highly populated level at 4.7 MeV was identified as the 4^+ state of the $(d_{\frac{5}{2}})^{-2}$ configuration. The comparison between the level schemes and the spectroscopic factors of ^{26}Al and ^{26}Mg nuclei confirms this result. (France)

14036 THERMAL-NEUTRON CAPTURE CROSS SECTION AND RESONANCE CAPTURE INTEGRAL OF ^{80}Kr. Bradley, James G.; Johnson, Walter H. (Univ. of Minnesota, Minneapolis). Nucl. Sci. Eng.; 47: No. 1, 151-3(Jan 1972).

The thermal-neutron capture cross section and resonance capture integral of ^{80}Kr have been measured in reactor irradiations using mass spectrometric techniques. Values of $\sigma_{2200} = 11.3 \pm 0.4$ b and I (0.4 eV) = 56.1 ± 2.8 b are reported. (auth)

14037 SPIN FLIP IN THE INELASTIC SCATTERING OF 12 MeV PROTONS FROM ^{50}Cr AND ^{52}Cr. Sweeney, W. E. Jr.; Ellis, J. L. (Rice Univ., Houston, Tex.). Nucl. Phys.; A177: No. 1, 161-73(1971).

Angular distributions of the absolute spin-flip probability during inelastic scattering of 12 MeV protons have been measured for the reactions ^{50}Cr(p,p')^{50}Cr*(0.78 MeV) and ^{52}Cr(p,p')^{52}Cr*(1.43 MeV). The data are compared with collective-model DWBA calculations which include the effects of averaging over the γ-ray detector acceptance angle. The effects of varying the spin-orbit distortion in the collective-model form factor and of changing the optical-model parameter set are discussed. The angular distribution for ^{50}Cr exhibits a large peak at back angles characteristic of a direct reaction and agrees qualitatively with the DWBA calculations. The angular distribution for ^{52}Cr exhibits two peaks of nearly equal magnitude and does not agree with the theoretical calculations. (auth)

14038 INELASTIC SCATTERING OF 50 MeV PROTONS BY ^{45}Sc. Mani, G. S. (Univ. of Manchester, Eng.). Nucl. Phys.; A177: No. 1, 197-204(1971).

Inelastic proton scattering from ^{45}Sc at 49.75 MeV has been studied with protons from a linear accelerator. Differential cross section for twenty-seven excited states up to an excitation of 4.51 MeV in ^{45}Sc were obtained. The angular distribution was fitted using DWBA with first-order collective form factors. The results are discussed in terms of the structure of ^{45}Sc. (auth)

14039 NEUTRON PICK-UP FROM THE EVEN CALCIUM ISOTOPES. Rapaport, J. (Ohio Univ., Athens); Dorenbusch, W. E.; Belote, T. A. Nucl. Phys.; A177: No. 1, 307-21(1971).

The (^{3}He,α) reactions have been performed at 13.0 MeV bombarding energy from a target consisting of approximately equal amounts of the five stable even calcium isotopes. Angular distributions for the strongest $l_n = 3(1f_{\frac{7}{2}})$, $l_n = 2(1d_{\frac{3}{2}})$, and $l_n = 0(2s_{\frac{1}{2}})$ transitions were measured and analyzed using the distorted-wave Born approximation. Optical-model parameters were obtained from 13.0 MeV ^{3}He elastic-scattering measurements. An isospin term in the neutron bound-state potential was used in the analysis. Spectroscopic factors were extracted and are compared with other reported values. (auth)

14040 ^{36}Ar(d,α)^{34}Cl REACTION AT 19 MeV. Horoshko, R. N.; Shapiro, M. H. (Univ. of Rochester, N. Y.). Nucl. Phys.; A180: No. 1, 37-48(1972).

The ^{36}Ar(d,α)^{34}Cl reaction was used to study level properties of ^{34}Cl up to 3.6 MeV excitation. The observed angular distributions are found to exhibit a systematic L-dependent structure which confirms the spin and parity assignments for most of the known 1^+ states and places J^π limits for some other states. The DWBA analysis was performed using the $s_{\frac{1}{2}}-d_{\frac{3}{2}}$ shell-model wave functions of Glaudemans. The calculated relative cross sections are in satisfactory agreement with measurements for only a few low-lying states. Considerable configuration mixing in ^{34}Cl is indicated. (auth)

14041 NUCLEAR STRUCTURE OF ^{23}Na: THE ^{22}Ne(^{3}He,d) REACTION. Powers, J. R. (Univ. of Pennsylvania, Philadelphia); Fortune, H. T.; Middleton, R.; Hansen, Ole. Phys. Rev., C; 4: No. 6, 2030-46(Dec 1971).

Using the ^{22}Ne(^{3}He,d)^{23}Na reaction at a bombarding energy of 15 MeV, excitation energies and angular distributions have been obtained for 96 levels below $E_x = 10.2$ MeV in ^{23}Na. Data were recorded in 3.75° steps in a multiangle spectrograph. Angular distributions were compared with distorted-wave Born-approximation predictions; values of transferred angular momentum and spectroscopic strength were extracted for 42 levels, including the three lowest $T = \frac{3}{2}$ states. An empirical forward-angle J dependence has been used to distinguish between $J_f^\pi = \frac{3}{2}^+$ and $\frac{5}{2}^+$ for $l_p = 2$ transfers. The summed $l_p = 0$ and $l_p = 2$ spectroscopic strengths agree with theoretical expectations. The results of the present investigation are combined with previous information and discussed in terms of the rotational model. The low-lying negative-parity states are examined in terms of their particle or hole character. The results for both positive- and negative-parity states suggest significant deviations from the predictions of a simple rotational model, even with band mixing. (auth)

14042 PROPERTIES OF LEVELS IN ^{34}Cl. Hyder, A. K. Jr.; Harris, Gale I. (Wright-Patterson AFB, Ohio). Phys. Rev., C; 4: No. 6, 2046-60(Dec 1971).

22 levels of ^{34}Cl below $E_x = 4.7$ MeV are populated by the γ-ray

decay of the three resonances at E_p = 1058, 1098, and 1121 keV in the reaction $^{33}S(p,\gamma)^{34}Cl$. These resonances, selected for study because of their dominant modes of γ decay to levels above 2.7 MeV for which limited prior data exist, were investigated with an 80-cm^3 Ge(Li) detector, and with Ge(Li)-NaI coincidence and angular-correlation techniques. The results obtained for levels below 2.3 MeV are in general agreement with other recent work. A new result is a probable J = 3 assignment for the 2.180-MeV level. For higher-lying levels, γ-ray decay schemes and excitation energies with errors in the range from ±0.3 to ±2.3 keV were determined for 14 bound states in the range 2.3 < E_x < 4.7 MeV and the three resonance levels. The reaction Q value was determined with the result Q = 5139.9 ± 0.9 keV. The following J^π assignments (energies in MeV) result from the combination of the present work with a recent $^{33}S(^3He,d)^{34}Cl$ study: 2.72, 2$^-$; 3.55, 3$^-$; 3.60, 4$^{(-)}$; 3.63, 5$^-$; 3.77, 1$^-$; 3.98, 3$^-$; 4.08, 4$^-$; 4.14, 2; 4.35, probably 1$^-$; 4.42, 1, 2, or 3; 4.51, probably 2$^-$; and 4.64, 2, 1, or 3. The resonance level assignments are $J^\pi(1058) = 3^{(-)}$, $J^\pi(1098) = 4^{(-)}$, and $J^\pi(1121) = 1^-$. It is shown that the three resonances are probably each odd-parity T = 1 levels. The probable shell-model configurations of some of the odd-parity levels are discussed. (auth)

14043 LEVELS AND TRANSITION RATES IN ^{53}Mn FROM THE $^{53}Cr(p,n)^{53}Mn$ AND $^{53}Cr(p,\gamma)^{53}Mn$ REACTIONS. Wiest, J. E.; Robertson, C.; Gabbard, F.; McEllistrem, M. T. (Univ. of Kentucky, Lexington). Phys. Rev., C; 4: No. 6, 2061-73(Dec 1971).

Differential cross sections of the (p,n) reactions have been measured as a function of angle at several proton energies from 2.6 to 5.9 MeV. Neutron groups corresponding to the ground and 21 excited levels have been observed, and excitation energies fixed to within ±5 keV in these measurements. The good agreement between the measured cross sections and those calculated in the Wolfenstein–Hauser–Feshbach (WHF) formalism for levels of known spin and the agreement between measured and calculated neutron angular distributions permitted tentative assignments to many levels of unknown spin. Angular distributions of the (p,nγ) transitions were measured at 4.9-MeV proton energy, with transitions from 19 excited levels observed. A decay scheme and excitation energies with ±2-keV uncertainty were obtained from the γ-ray measurements. Analysis of the angular distributions in the WHF formalism together with the neutron measurements provided the following excitation energies in keV and spin assignments: 2272, 5/2, 7/2; 2405, 3/2; 2571, (7/2); 2685, 7/2; 2949, 5/2; 3004, (3/2, 5/2); 3199, 5/2, 7/2, 3/2; 3248, (3/2). Tentative assignments are in parentheses. The level and decay schemes are in good agreement with mixed-configuration shell-model calculations for the first levels of a given spin. For higher levels the comparison of calculated and measured schemes suggests an inadequate model space in those calculations which allow only one proton excited out of the $f_{\frac{7}{2}}$ shell. (auth)

14044 LIFETIMES OF SOME LOW-LYING LEVELS OF ^{52}Cr. Sprague, S. W.; Arns, R. G.; Brunner, B. J.; Caldwell, S. E.; Rozsa, C. M. (Ohio State Univ., Columbus). Phys. Rev., C; 4: No. 6, 2074-9(Dec 1971).

The mean lifetimes of levels of ^{52}Cr to 4.5 MeV in excitation energy have been measured by the Doppler-shift-attenuation method. States in ^{52}Cr were populated by the reaction $^{51}V(^3He,d)^{52}Cr$ at 11.0 MeV using natural vanadium targets. γ rays were detected with a 37.5-cm^3 Ge(Li) detector at 30, 90, and 150° to the beam axis. The following mean lifetimes (in units of 10^{-13} sec) were found: τ(1434-keV level) = 9.9, τ(2369) = 15.0, τ(2766) = 20, τ(2965) = 6.8, τ(3114) > 29, τ(3162) = 1.2, τ(3414) = 3.2, τ(3469) > 50, τ(3472) > 27, τ(3617) > 11, τ(3947) = 1.5, τ(4015) = 8.4, τ(4040) = 7.4, τ(4563) = 3.9. The lifetime results combined with the results of previous particle-γ correlation experiments indicate $J^\pi = 4^+$ and 5^+ for the 3414- and 4015-keV levels, respectively. (auth)

14045 SHAPES OF ANGULAR DISTRIBUTIONS IN THE REACTION $^{89}Y(^3He,t)^{89}Zr$ TO ANTIANALOG AND OTHER $T_<$ STATES. Hinrichs, R. A.; Trentelman, G. F. (Michigan State Univ., East Lansing). Phys. Rev., C; 4: No. 6, 2079-82(Dec 1971).

The reaction $^{89}Y(^3He,t)^{89}Zr$ to $T_<$ states in ^{89}Zr shows that the angular distributions have shapes characteristic of nonallowed L transfers and are in disagreement with microscopic predictions. The antianalog states appear not to be unique in possessing this feature. (auth)

14046 STUDY OF LOW-LYING STATES IN ^{53}Fe BY THE REACTION $^{50}Cr(\alpha,n\gamma)^{53}Fe$. Cochavi, S.; Nagatani, K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 4: No. 6, 2083-9(Dec 1971).

Low-lying states in ^{53}Fe have been studied via the reaction $^{50}Cr(\alpha,n\gamma)^{53}Fe$. A Ge(Li) γ spectrum was measured in coincidence with neutrons to identify low-lying states and their γ transitions. A threshold study with a Ge(Li) detector was made at bombarding energies between 5.6 to 10.0 MeV. The n–γ and the threshold studies together with γ–γ coincidences suggest the existence of states at 741 ± 1-, 1328 ± 1-, 1423 ± 1-, and 1697 ± 1-keV excitation energies. An n–γ delayed coincidence measurement has been done for the 741-keV γ ray. The resulting mean life is τ = 92 ± 2 nsec. (auth)

14047 MAGNETIC TRANSITION STRENGTH IN ^{32}S AND ^{40}Ca FROM 180^0 ELECTRON SCATTERING. Fagg, L. W. (Naval Research Lab., Washington, D. C.); Bendel, W. L.; Cohen, L.; (and others). Phys. Rev., C; 4: No. 6, 2089-96(Dec 1971).

The magnetic excitation structures of ^{32}S and ^{40}Ca have been studied by 180° inelastic electron scattering from natural targets of CaS and Ca at energies of 39 and 56 MeV. The significant feature of the ^{32}S spectrum in the fragmentation of the $\Delta T = 1$ magnetic dipole strength into transitions to several levels in contrast to the strong concentration into a very few that is observed in ^{20}Ne, ^{24}Mg, and ^{28}Si. In the ^{32}S spectra excitation peaks are observed at 8.13, 10.82, 11.14, 11.62, 13.37, and 13.85 MeV. Analyses of the peaks at 8.13, 11.14, and 11.62 MeV yield M1 ground-state transition widths Γ_0 of 2.8, 18.9, and 9.7 eV, respectively. Peaks in the ^{40}Ca spectra are observed at 5.94, 6.94, 8.43, and 10.34 MeV. The peaks at 8.43 and 10.34 MeV are found to be due to an M2 transition, $\Gamma_0 = 2.6 \times 10^{-2}$ eV, and a possible M1 transition, $\Gamma_0 = 7.0$ eV, respectively. The analyses of the remaining peaks in the ^{32}S and ^{40}Ca spectra are discussed. The ^{32}S results are examined in terms of the theory of Kurath. (auth)

14048 NON-NORMAL PARITY STATES IN A = 40 AND 41 NUCLEI. Chen-tsai, C. T.; Hsieh, S. T.; Lee, T. Y. (Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., C; 4: No. 6, 2096-9(Dec 1971).

The energy levels of the positive-parity states in ^{41}Sc (^{41}Ca) and ^{41}K are calculated by an effective particle-hole potential determined by a least-squares fit of the low-lying levels of the negative-parity states in ^{40}Ca. Some definite predictions are made on the spin-parity assignment for a few low-lying levels of ambiguous experimental spin-parity determination in ^{41}Sc. (auth)

14049 STUDY OF THE HARTREE–FOCK-MODEL PREDICTIONS FOR STATIC AND DYNAMIC PROPERTIES OF ^{20}Ne, ^{24}Mg, ^{28}Si, AND ^{32}S. Ford, W. F. (National Aeronautics and Space Administration Lewis Research Center, Cleveland); Braley, R. C.; Bar-Touv, J. Phys. Rev., C; 4: No. 6, 2099-22(Dec 1971).

The deformed Hartree–Fock method is tested for the first time in a comprehensive manner by investigating a wide range of static and dynamic nuclear properties for certain light nuclei. Intrinsic spectra are obtained for the nuclei ^{20}Ne, ^{24}Mg, ^{28}Si, and ^{32}S; in addition, energy-level spectra, nuclear radii, electromagnetic transition rates, electron scattering form factors, inelastic $0^+ \rightarrow 2^+$ proton scattering cross sections, and excited-state quadrupole moments are calculated and, wherever possible, compared with experiment. The general results indicate that the Hartree–Fock method may legitimately be extended beyond its common use in structure studies. Both static properties and dynamic ones are reasonably well reproduced in the region where the single-determinant approximation is an acceptable starting point. (auth)

14050 RATIO OF PHOTODISINTEGRATION TO ELECTRODISINTEGRATION OF Al, Fe, AND Ta BOMBARDED WITH 5.0-GeV ELECTRONS. Fulmer, C. B. (Oak Ridge National Lab., Tenn.); Toth, K. S.; Williams, I. R.; Dell, G. F. Phys. Rev., C; 4: No. 6, 2123-5(Dec 1971).

The cross-section ratio for photodisintegration to electrodisintegration was measured for targets of aluminum, iron, and tantalum bombarded with 5.0-GeV electrons. These ratios (or F values) were determined for a total of six cascade-evaporation reactions in which as many as 12 nucleons are emitted from the target nucleus. The F values for the six reactions average 2.1, and vary little with target mass and with the number of emitted nucleons. In addition, F values were also measured for two other reactions whose mechanisms involve fragmentation and/or fissionlike processes. The average of these two F values is 3.25 or about 50% larger than for the cascade-evaporation reactions. (auth)

14051 ENERGY LEVELS AND TRANSITIONS IN ^{75}As FROM THE (n,n'γ) REACTION. Wilenzick, R. M.; Dave, V. R.; Nelson, J. A. (Tulane Univ., New Orleans). Phys. Rev., C; 4: No. 6, 2126-30(Dec 1971).

High-resolution measurements of the deexcitation γ rays from the $^{75}As(n,n'\gamma)$ reaction have been made at 0.1-MeV intervals for incident neutrons between the energies of 0.8 and 2.2 MeV. These γ rays are assigned to energy levels up to an excitation of 1606 keV in ^{75}As. The level scheme is compared with that obtained in a recent resonance scattering experiment, and several new levels are proposed. Branching ratios and differential γ-ray production cross sections at 95° are determined. (auth)

14052 J DEPENDENCE FOR L = 2 (α,p) TRANSITIONS IN s-d SHELL NUCLEI. August, L. S.; Shapiro, P.; Cooper, L. R.; Bond, C. D. (Naval Research Lab., Washington, D. C.). Phys. Rev., C; 4: No. 6, 2291-3(Dec 1971).

The J dependence for L = 2 transfer has been studied at E_α = 28.8 MeV for the (α,p) reactions on ^{32}S and ^{24}Mg. The results are compared with previous $^{28}Si(\alpha,p)^{31}P$ data where no J dependence is observed for L = 2 transfer. (auth)

14053 RESOLUTION OF FIXED-GEOMETRY OPTICAL-MODEL AMBIGUITIES. Watson, B. D.; Robson, D.; Tolbert, D. D.; Davis, R. H. (Florida State Univ., Tallahassee). Phys. Rev., C; 4: No. 6, 2240-9(Dec 1971).

In order to test a procedure for resolving the problem of discrete real-well-depth ambiguities found in optical-model analyses, α particles were elastically scattered from ^{70}Ge, ^{90}Zr, ^{107}Ag, and ^{140}Ce at incident energies from 0.6 to 1.2 times the classical Coulomb-barrier height for each nucleus. The real and imaginary nuclear potential-well radii and the Coulomb radius (assuming a uniformly charged sphere) for each nucleus were taken to be $R = R_C = r_0(A_{Alpha}^{1/3} + A_{Target}^{1/3})$, where $r_0 = 1.22$ F. A diffuseness of 0.57 F was used throughout. For three of the nuclei, only one pair of real (U) and volume-imaginary (W) potentials was found, with the real-well depth for ^{90}Zr showing a slight energy dependence. The potentials obtained were (in MeV): U = 23.5, W = 11.0 for ^{70}Ge; U ~ 22, W ~ 10.3 for ^{90}Zr; U = 25.5, W = 14.5 for ^{107}Ag; and U = 18.0, W = 6.0 for ^{140}Ce. Analysis of angular distributions taken with 15–18 MeV α particles did not yield evidence of expected ambiguities in the real-well depth, so further calculations were performed in which the effect of absorption was more generally explored. The usefulness of the proposed method was found to be limited to cases where the absorption is either ineffective, or small compared with the average spacing between single-particle levels of the same spin and parity. (auth)

14054 PROPERTIES OF THE 2.443- AND 3.003-MeV LEVELS IN ^{57}Ni. Gould, C. R. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Roberson, N. R.; Mitchell, G. E.; Tilley, D. R. Phys. Rev., C; 5: No. 1, 281-3 (Jan 1972).

The reaction $^{54}Fe(\alpha,n)^{57}Ni$ was used to investigate the properties of levels at 2.443 and 3.003 MeV in ^{57}Ni. A spin–parity assignment of $5/2^-$ is made for the 2.443-MeV level. The 3.003-MeV level is found to have possible spins of 3/2 or 5/2 and a mean lifetime of 11 ± 6 fsd. (auth)

14055 Al(n,xγ) REACTIONS FOR $5.3 \le E_n \le 9.0$ MeV. Dickens, J. K. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 5: No. 1, 100-11(Jan 1972).

Interactions of neutrons with aluminum were studied by measuring γ-ray-production cross sections. Spectra were obtained for incident mean neutron energies E_n = 5.35, 5.85, 6.4, 6.9, 7.45, 7.95, 8.5, and 9.0 MeV. The γ rays were detected using a coaxial Ge(Li) detector of 30-cm^3 active volume. Data were obtained for γ-ray scattering angles of 55° for all E_n, 90° for all E_n except 5.35 MeV, and 75° for E_n = 6.4 and 7.45 MeV. Time of flight was used with the detector to discriminate against pulses due to neutrons and background radiation. Absolute cross sections for production of γ rays were obtained for the incident neutron energies quoted above. The cross sections are compared, where possible, with previous measurements with good agreement. The spectra were studied for γ rays which could be associated with deexcitation of nuclear levels having unknown decay modes. γ rays were found having energies appropriate for ground-state decay of levels at excitation energies E_n = 5.155, 5.414, 5.434, 6.514, 6.821, 6.956, 7.920, 7.411, 7.471, 7.56 (doublet), 7.655, 8.148, and 8.184 MeV. (auth)

14056 SEARCH FOR 1p NEUTRON STRENGTH IN ^{31}S BY THE REACTION $^{32}S(^3He,\alpha)^{31}S$. Bhatia, T. S. (Univ. of Pittsburgh); Daehnick, W. W.; Wagner, G. J. Phys. Rev., C; 5: No. 1, 111-17 (Jan 1972).

Levels of ^{31}S above E_n = 4.5 MeV were studied with 18-MeV ^3He ions via the neutron-pickup reaction $^{32}S(^3He,\alpha)^{31}S$. The α particles were detected by position-sensitive counters placed along the focal plane of a spectrograph. The experimental energy resolution was 13 to 18 keV full width at half maximum, and permitted the resolution of some multiplets that previously had been interpreted as single states. Strongly structured angular distributions for nine well-resolved α-particle groups were obtained over the angular range $7.5 \le \theta \le 45°$. The l values and spectroscopic factors for the transferred neutrons were extracted by comparison with distorted-wave calculations. The apparent absence of the bulk of the 1p neutron-pickup strength is discussed. (auth)

14057 REACTION $^{86}Kr(d,^3He)^{85}Br$. May, E. C.; Lewis, S. A. (Univ. of California, Davis). Phys. Rev., C; 5: No. 1, 117-19(Jan 1972).

The ground state and first four excited states of ^{85}Br observed in the reaction $^{86}Kr(d,^3He)^{85}Br$ at 0.0, 0.348, 1.169, 1.792, and 2.310 MeV was assigned spins and parities of $3/2^-$, $5/2^-$, $(3/2)^-$, $(1/2)^-$, and $(5/2^+)$, respectively. (auth)

14058 STATES IN ^{36}Ar EXCITED BY 180° ELECTRON SCATTERING. Fagg, L. W.; Bendel, W. L.; Jones, E. C. Jr.; Cohen, L.; Kaiser, H. F. (Naval Research Lab., Washington, D. C.). Phys. Rev., C; 5: No. 1, 120-4(Jan 1972).

Magnetic transitions in ^{36}Ar were investigated by 180° electron scattering from an isotopically enriched gaseous target at energies of 39 and 56 MeV. As in the case of ^{32}S, considerable fragmentation of the magnetic dipole strength is evident. Magnetic dipole transitions are observed at 10.05 and 11.25 MeV with ground-state transition widths of 6.2 and 8.9 eV, respectively. A magnetic quadrupole transition is observed at 8.44 MeV with a ground-state transition width of 10.6×10^{-3} eV. Two possible magnetic quadrupole transitions and one possible magnetic dipole transition are observed at 7.46, 11.58, and 12.09 MeV, respectively. Ambiguous results were obtained as to the multipolarity of two transitions at 9.27 and 10.55 MeV. The experimental results are discussed in terms of the theory of Kurath. (auth)

14059 ELASTIC ELECTRON SCATTERING FROM Zn ISOTOPES. Neuhausen, R.; Lightbody, J. W. Jr.; Fivozinsky, S. P.; Penner, S. (National Bureau of Standards, Washington, D. C.). Phys. Rev., C; 5: No. 1, 124-8(Jan 1972).

Elastic electron scattering from the stable even–even Zn isotopes was measured in the region of the first diffraction minimum ($0.3 \le q \le 1.1$ fm^{-1}). The cross-section ratios for each pair of isotopes were used to determine the change in the rms radius. The rms radius follows an $A^{1/3}$ law between ^{64}Zn and ^{66}Zn and between ^{68}Zn and ^{70}Zn, whereas between ^{66}Zn and ^{68}Zn the rms radius decreases significantly. (auth)

14060 BETA DECAY OF ^{39}Cl. Engelbertink, G. A. P.; Warburton, E. K.; Olness, J. W. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 5: No. 1, 128-38(Jan 1972).

The β^- decay of ^{39}Cl to states of ^{39}Ar was studied using a Ge(Li) detector. ^{39}Cl was produced in the reaction $^{37}Cl(t,p)^{39}Cl$ at E_t = 3.0 MeV by bombarding $BaCl_2$ targets enriched to 96.1% in ^{37}Cl. The half-life was measured to be 56.2 ± 0.6 min. Ten γ-ray transitions were observed including seven γ rays not seen previously in the ^{39}Cl decay. Ge(Li) versus NaI(Tl) coincidence measurements were used to determine the placement of these γ-ray transitions in the ^{39}Ar level scheme. The measured γ-ray intensities determine new β-ray branches of ≤0.08%, (2.61 ± 0.11)%, (2.29 ± 0.12)%, and (0.60 ± 0.05)% to ^{39}Ar levels at 2093, 2358, 2503, and 2829 keV with log-ft values of ≥8.03, 6.14 ± 0.04, 5.96 ± 0.04, and 5.84 ± 0.06, respectively. The latter two log-ft values lead to spin restrictions of 1/2, 3/2, or 5/2 for the 2305- and 2829-keV ^{39}Ar levels and strongly suggest even parity for both states. Other previously observed β-ray branches were confirmed. Accurate excitation energies with errors between 0.05 and 1.0 keV were obtained for the ^{39}Ar states involved. (auth)

14061 BETA DECAY OF THE ^{26}Al GROUND STATE. Samworth, E. A.; Warburton, E. K.; Engelbertink, G. A. P. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 5: No. 1, 138-42(Jan 1972).

The decay scheme of the ground state of ^{26}Al was reexamined by measurement of its γ-ray spectrum with Ge(Li) detectors. The γ-ray spectrum shows very strong positron annihilation radiation, a strong peak at 1808.65 ± 0.07 keV, a weak peak at 1129.67 ± 0.10 keV, and a very weak peak at 2938 keV. These γ-ray energies correspond to transitions from the first and second excited states of ^{26}Mg, which were determined more accurately in this experiment. The ^{26}Al branching ratios, calculated from the γ-ray relative intensities, are (82.1 ± 2.5)% positron emission to the 1809-keV level, (15.2 ± 2.5)% electron capture to that same level, and (2.7 ± 0.2)% electron capture to the 2938-keV level of ^{26}Mg. The 2938-keV state decays (10.2 ± 2.0)% directly to the ground state and (89.8 ± 2.0)% by cascade. These branching ratios combine with previous results to give a half-life of $(7.16 \pm 0.32) \times 10^5$ y for the ground state of ^{26}Al. (auth)

14062 LEVELS OF ^{50}Mn FROM THE REACTION $^{50}Cr(^3He,t)^{50}Mn$. McKenna, C. M. (Florida State Univ., Tallahassee); Kemper, K. W.; Fox, J. D.; Nelson, J. W.; Ball, J. B. Phys. Rev., C; 5: No. 1, 145-52(Jan 1972).

Levels of ^{50}Mn were observed via the $^{50}Cr(^3He,t)^{50}Mn$ reaction at 39.45 MeV bombarding energy by using the broad-range magnetic spectrograph at the Oak Ridge isochronous cyclotron. Differential cross sections were measured in the angular range from 4 to 56° in 4° intervals. A total of 29 states below 4 MeV excitation in ^{50}Mn were identified. A microscopic distorted-wave Born-

approximation analysis, including a tensor force and assuming pure $f_{\frac{7}{2}}$ configurations, was used to obtain J^{π} assignments for nine levels below 2-MeV excitation. Anomalies reported in previous (^{3}He,t) studies were observed: the interaction strengths required to normalize the fits for natural-parity states increased with J; and, for the high-spin $T_<$ states, angular shifts between the theoretical and experimental angular distributions were observed. The energy level scheme is compared with results of ^{50}Cr(p,n)^{50}Mn and ^{50}Cr(p,nγ)^{50}Mn experiments, as well as with a theoretical level scheme from shell-model calculations. (auth)

14063 HARTREE–FOCK–BOGOLYUBOV CALCULATIONS FOR EVEN–EVEN NUCLEI IN p–f SHELL. Parikh, Jyoti K. (Bhabha Atomic Research Centre, Bombay). Phys. Rev., C: 5: No. 1, 153-7(Jan 1972).

Hartree–Fock–Bogoliubov (HFB) calculations are done for some even–even nuclei in the p–f shell with ^{40}Ca taken as a doubly closed core. It is observed that the nuclear shape changes from a prolate to an oblate shape, and the pairing correlations increase in the neutron states and decrease in the proton states as one goes from the Ti to the Zn and Ge isotopes. Whether the $f_{\frac{7}{2}}$-shell-closure approximation, in which ^{56}Ni is taken as a closed core, is valid or not is discussed by comparing the calculated occupational probabilities of the $f_{\frac{7}{2}}$ shell and the break in the pair separation energy at ^{56}Ni with the experimental values. Projected HFB spectra are obtained for ^{64}Zn, ^{66}Zn, and ^{70}Ge. Reasonable agreement with the experimental spectra is obtained for ^{66}Zn and ^{70}Ge. The reasons for the failure of the present method in ^{64}Zn are discussed. (auth)

14064 MEASUREMENTS AND OPTICAL-MODEL ANALYSES OF QUASIELASTIC (p,n) REACTIONS. Wong, C.; Anderson, J. D.; McClure, J. W.; Pohl, B. A.; Wesolowski, J. J. (Univ. of California, Livermore). Phys. Rev., C: 5: No. 1, 158-63(Jan 1972).

Differential cross sections for quasi-electric (p,n) scattering from 17 to 20 MeV bombarding energies were measured for Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Se, Zr, and Nb in either 7.5 or 15° steps between 3 and 157.5°. A complex isospin-dependent potential, whose strengths and form factors are deduced from the Becchetti and Greenless global neutron and proton optical potentials, gave a good overall description of the average behavior for the 17- to 20-MeV quasi-elastic (p,n) data. In particular, volume real and surface imaginary isospin form factors with strengths of 96 and 48 MeV, respectively, yielded a reasonable fit to both the shape and magnitude of the Fe and Nb quasi-elastic (p,n) data. On the other hand, using a purely real isospin potential requires a surface interaction of strength 126 MeV for Fe and a volume interaction of strength 107 MeV for Nb. The calculations were extended to 30 and 50 MeV bombarding energy and compared with the measurements of others. At 30 MeV there is good agreement as regards both shape and magnitude; at 50 MeV the shapes are reasonably well described, but the calculated magnitudes are uniformly higher for most of the targets investigated. It is suggested that the 50-MeV data are consistent with a 30% decrease in the isospin strength in going from 30 to 50 MeV. (auth)

14065 STRUCTURE OF ^{41}Sc BY PROTON RADIATIVE CAPTURE. Clark, Ronald Bruce. Houston, Tex.; Rice Univ. (1971). 292p. University Microfilms Order No. 71-26,275.

Thesis.

The investigation of the structure of ^{41}Sc by means of the ^{40}Ca(p,γ)^{41}Sc reaction was undertaken in the range of proton energies between 4.8 and 12.5 MeV (corresponding to a range of excitation in ^{41}Sc from 5.8 to 13.2 MeV). The measurements were based on the detection of the positron activity of the ground state of ^{41}Sc ($E_{max}(\beta^+)$ = 5.47 MeV, $\tau_{\frac{1}{2}}$ = 0.6 sec). Since all excited states of ^{41}Sc are proton unstable and, therefore, any radiative cascade is competing with a much faster proton emission, the presence of this activity is strong evidence for proton capture followed by a radiative transition directly to the ground state. The experimental results consist of an excitation function over the energy range specified above and a series of halflife measurements to determine the contribution to the yields from the competing ^{40}Ca(p,α)^{37}K(β^+)^{37}Ar reaction ($E_{max}(\beta^+)$ = 5.12 MeV, $\tau_{\frac{1}{2}}$ = 1.23 sec). Many hundreds of resonances were observed throughout the energy range along with a non-resonant yield. The rapid increase in the (p,α) contribution above 8 MeV made it impractical to study the (p,γ) reaction above an excitation energy of 11 MeV. In the region of reasonably well-spaced levels below 8 MeV over 220 resonances were identified and their energies, relative yields, and integrated cross sections tabulated. Correspondence between capture and proton scattering resonances was made for 77 levels, confirming or establishing spin assignments and enabling the evaluation of the reduced transition probabilities for 66 of these levels. The E1 and M1 transition strengths were found to exhibit an unexpected linear dependence on the reduced proton widths of the states emitting these radiations. Theoretical estimates of the continuum and compound-nucleus cross sections for the capture reaction were performed using the extended Lane–Lynn direct-capture and the statistical compound-nucleus models. It was found that while the predicted continuum cross section agreed well with the data, the statistical predictions (obtained assuming the E1 mode as the dominant transition multipole) underestimated the observed average resonance cross section above 8 MeV by at least a factor of two. In order to account for the average resonance cross section, the behavior of the data in the lower energy region (specifically the relative contributions of the different multipoles to the observed yield and the correlation between single-particle widths and transition strengths) was extrapolated into the region above 8 MeV. On this basis it was found that about half of the cross section results from E1 and half from mixed M1-E2 transitions. Further the estimated E2 transition strength in the 8–11 MeV region exhausts about 50% of the energy-weighted sum-rule limit for E2 transitions. (Diss. Abstr. Int., B)

14066 STUDY OF THE REACTION ^{20}Ne(^{3}He,d)^{21}Na AND ITS CORRELATION TO THE REACTION ^{23}Na(p,t)^{21}Na. Martin III, Ashley Marvin. Tallahassee, Fla.; Florida State Univ. (1971). 111p. University Microfilms Order No. 71-25,788.

Thesis.

Thirteen energy levels at E_x < 5.0 MeV have been observed in ^{21}Na through one or both of the reactions ^{20}Ne(^{3}He,d)^{21}Na and ^{23}Na(p,t)^{21}Na for bombarding energies of $E_{^3He}$ = 18.0 MeV and E_p = 34.0 MeV. Angular distributions forward of 105° were measured for both the bound and unbound states. A direct reaction analysis of the ^{20}Ne(^{3}He,d)^{21}Na reaction leading to the bound states of ^{21}Na yields spectroscopic factors which are compared with values from calculations based on the Nilsson model with and without hand mixing. Two neutron pickup calculations based on calculated and measured spectroscopic factors are presented and compared with the ^{23}Na(p,t)^{21}Na bound state reaction data. (Diss. Abstr. Int., B)

14067 UNEXPECTED $\frac{1}{2}^-$ STATE IN ^{55}Mn. Peterson, R. J.; Pittel, S.; Rudolph, H. (Univ. of Colorado, Boulder). Phys. Lett.; 37B: No. 3, 278-81(29 Nov 1971).

The angular distribution observed for the ^{57}Fe(p,τ) reaction to a level near 1.29 MeV in ^{55}Mn shows a striking rise at small angles. This signature of an L = 0 transferred pair requires the existence of a new state nearly degenerate with the $^{11}\frac{1}{2}^-$ state known at 1.292 MeV. Comparison of the (p,τ) and (d,α) angular distributions implies a spin of $\frac{1}{2}^-$ for this state. Shell model calculations including both 2p-3h and 3p-4h states correctly predict this level and its properties. (auth)

14068 GAMMA-GAMMA ANGULAR CORRELATIONS IN THE DECAY OF 17.8 MIN ^{88}Rb AND 9.7 MIN ^{125m}Sn. Kawase, Yoichi; Okano, Kotoyuki; Uehara, Shinichi; Hayashi, Takeo. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 1-8(1971).

Gamma-gamma angular correlations of four cascades in the decay of 17.8-min ^{88}Rb and of five cascades in the decay of 9.7-min ^{125m}Sn were measured with a multicounter goniometer to study the nuclear shell effects on the nuclei near the magic number 50. The spins of levels at 3489, 4514, 4846, and 4855 keV in ^{88}Sr were determined to be 1, 2, 3, and 2, respectively. The E2/M1 mixing ratio of the 1382 keV $2_2^+ - 2_1^+$ transition in ^{88}Sr agrees well with the single-particle limit. The reduced transition rates from the first excited state to the ground state in ^{125}Sb were found to be consistent with the shell-model description of these states. (auth)

14069 HIGH ENERGY ELASTIC ELECTRON SCATTERING FROM ^{24}Mg, ^{28}Si, AND S. Li, G. C.; Sick, I.; Yearian, M. R. (Stanford Univ., Calif.). Phys. Lett.; 37B: No. 3, 282-4(29 Nov 1971).

High momentum transfer elastic electron scattering data (q = 0.8 – 3.7 fm^{-1}) from ^{24}Mg, ^{28}Si and S are presented and analyzed with phenomenological charge distributions ρ(r); an oscillation in ρ(r) due to shell-model structure is obtained. An analysis in terms of a Woods–Saxon potential is described and the 2s-1d occupation numbers are deduced. (auth)

14070 ACCURATE EXCITATION ENERGIES FOR SOME LEVELS OF ^{7}Be, ^{27}Al, ^{34}S, AND ^{37}Cl. Bock, G. J.; Samworth, E. A.; Olness, J. W.; Warburton, E. K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C: 5: No. 1, 284-5(Jan 1972).

Gamma-ray energy measurements utilizing a Ge(Li) detector result in excitation energies of 429.20 ± 0.10, 2127.52 ± 0.20, and 1726.44 ± 0.20 keV for the first excited states of ^{7}Be, ^{34}S, and ^{37}Cl; and 843.76 ± 0.07 and 1014.38 ± 0.10 keV for the first two excited states of ^{27}Al. (auth)

14071 STUDY OF LEVELS IN ^{64}Cu FROM THERMAL NEUTRON CAPTURE IN NATURAL COPPER. Holmberg, P.; Passi, P.; Rieppo, R. (Univ. of Oulu, Finland). Commentat. Phys.-Math.; 41: 311-7(Dec 1971).

Decay modes for levels and their positions in ^{64}Cu have been studied by means of thermal neutron capture in natural copper. Levels up to ≈2300 keV in ^{64}Cu are reached, and the population and decay of 26 levels are indicated. (auth) (Finland)

14072 GIANT DIPOLE STATES OF ^{58}Ni AND ^{60}Ni. Tanaka, Yasutoshi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 3, 787-801 (Sep 1971).

It is known that the photoneutron cross section integrated up to 25 MeV changes significantly from ^{58}Ni to ^{60}Ni. This fact is mainly due to the difference of the isospin structure of giant dipole states of these two nuclei. So these giant dipole states are studied in the Tamm–Dancoff approximation including the isospin. The valence neutrons are assumed to be in the $1p_{\frac{1}{2}}$ orbit. For comparison with experiment, the branching ratio of a proton and a neutron emission for every excited state is calculated. The qualitative tendency can be reproduced in the calculation. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 11664, 12099, 12101, 12130, 12131, 12312, 13152, 13157, 13200, 13386, 13521, 13843, 13936, 13937, 13939, 13955, 13956, 14005, 14006, 14008, 14025, 14026, 14050, 14053, 14064, 14068, 14182, 14185, 14192, 14193, 14204, 14219, 14224, 14231, 14237, 14239, 14244, and 14257.

14073 (AWRE-O-66/71) ELASTIC AND INELASTIC SCATTERING OF NEUTRONS IN THE ENERGY RANGE 1.0 to 5.0 MeV BY NATURAL NIOBIUM. Coles, R. E. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov 1971. 33p. Dep. NTIS (U. S. Sales Only). UK 40p.

The time-of-flight method was used to study fast neutron elastic and inelastic scattering by niobium in the energy range 1.0 to 5.0 MeV. Differential cross sections were measured at ten angles from 30 to 135°, at 0.5 MeV intervals between 1.5 and 5.0 MeV incident neutron energy, for elastic scattering, inelastic scattering to levels up to 2590 keV excitation in the target nucleus and inelastic scattering to a continuum above 2590 keV excitation. Excitation functions were derived from 125° yields measured at 0.2 MeV intervals between 1.0 and 3.0 MeV incident neutron energy for inelastic scattering. The continuum spectra for incident neutron energies between 3.5 and 5.0 MeV were analyzed in terms of statistical evaporation theory and parameters describing the secondary energy distributions of the continuum scattered neutrons extracted. No attempt was made to compare the data with theoretical predictions. However, comparisons are made with other published data where appropriate. (auth)

14074 (BARC-547) STUDIES OF K X-RAY EMISSION IN THE THERMAL FISSION OF ^{235}U AND SPONTANEOUS FISSION OF ^{252}Cf. Kapoor, S. S.; Kataria, S. K.; Murthy, S. R. S.; Nadkarni, D. M.; Ramamurthy, V. S.; Rama Rao, P. N.; Ramanna, R. (Bhabha Atomic Research Centre, Bombay (India)). 1971. IAEA Contract 535/RB. 68p. Dep. NTIS (U. S. Sales Only).

Detailed investigation of the K x-rays emitted in the thermal neutron fission of uranium-235 and in the spontaneous fission of californium-252 was undertaken in three different types of experiments. The first involved a three-parameter study of the kinetic energies of the pair fragments and the coincident K x-rays for the case of thermal fission of uranium-235 and provided information on the K x-ray yields as a function of average fragment mass and total kinetic energy. The second experiments were for the purpose of obtaining information on the K x-ray emission times as a function of the nuclear charge of the emitting fragment for uranium-235 fission. The third type of experiment on the correlated emission of the K x-rays for the case of spontaneous fission of californium-235 provided information regarding the average multiplicity of K x-rays and light-heavy correlation in the x-ray emission. (J.F.P.)

14075 (BARC-557) ANNUAL REPORT OF THE NUCLEAR PHYSICS DIVISION, 1970. Iyengar, P. K.; Murthy, N. S. Satya (eds.) (Bhabha Atomic Research Centre, Bombay (India)). 1971. 123p. Dep. NTIS (U. S. Sales Only).

A summary of research is given on nuclear, solid-state, and reactor neutron physics, seismology, and development of special nuclear instruments. A list of publications is included. (J.F.P.)

14076 (CNAEM-79) NEUTRON WIDTHS IN SLOW NEUTRON RESONANCES AND EFFECT OF THE DIFFUSE NUCLEAR EDGE ON LOW ENERGY NUCLEAR REACTIONS. Cansoy, Cetin (Cekmece Nuclear Research Center, Istanbul (Turkey)). Jan 1971. 52p. Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Ankara, Faculty of Science, Ankara, Turkey.

The s-wave character of low-energy neutron resonances was discussed. From experimental arguments it was concluded that s-wave neutron resonances were impossible. It was shown that the theoretical values of neutron widths of s-wave resonances were 10^4 to 10^5 times larger than the experimental values. The formulas giving the neutron widths for the cases of p, d, and f-wave resonances were developed and in this way the discrepancy between the theoretical and experimental values of neutron widths was removed. Using the new neutron width formulas the method of resonance analysis was modified. In the modified form of analysis of the experimental data one does not need the value of g (J). However, g (J) can be determined by using experimental total cross sections. The total cross section of ^{169}Tm was measured in the energy range from 0.35 and 3.2 eV with the CNAEM crystal spectrometer using the Be (12$\bar{3}$1) crystal planes as a monochromator. Applying the modified form of the method of resonance analysis to these experimental data the value of g (J) was found to be $^7/_4$. The total cross section of ^{159}Tb was also measured in the energy range from 0.35 to 3.65 eV with the CNAEM crystal spectrometer using the Be (12$\bar{3}$1) crystal planes as a monochromator. The resonance at 3.34 eV was fitted to a Breit–Wigner single-level formula by the method of least squares. Using the modified form of the method of resonance analysis the value of g (J) was found to be $^1/_8$. (auth)

14077 (COO-1672-24) RADIOCHEMICAL INVESTIGATIONS OF NUCLEAR PROPERTIES. Progress Report, October 1970–September 1971. Daly, Patrick J. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Sep 1971. Contract AT(11-1)-1672. 13p. Dep. NTIS.

Nuclear structure investigations in the region A = 180 to 200 are reported. Emphasis is on the level structure of ^{182}W and ^{184}W. No evidence was found for a 3-h isomer of ^{190}Re, which has been previously reported. Improvements in spectroscopic equipment are also mentioned. (R.W.R.)

14078 (EANDC(E)-140-U) PROGRESS REPORT ON NUCLEAR DATA RESEARCH IN THE EURATOM COMMUNITY, JANUARY 1–DECEMBER 31, 1970. (European-American Nuclear Data Committee). Aug 1971. 210p. (In several languages). Dep. NTIS (U. S. Sales Only).

Research in many different areas of nuclear physics done by Euratom countries is sketched. Most of the work is basic research of an experimental nature; however, there are also reports on reactor physics, chemistry, accelerators, and instrumentation. (R.W.R.)

14079 (FRNC-TH-124) METHODS OF PRODUCING α EMITTING NEUTRON DEFICIENT HEAVY NUCLEI WITH Z BETWEEN 82 AND 91. Reyss, Jean-Louis (Paris Univ., Orsay (France)). 1971. 56p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Work published on neutron deficient isotopes (Pb, Bi, Po, At, Rn, Fr, Ra, Ac, Th and Pa) up to June 1971 is recalled. Examination of the variations in the transition energies Q_α as a function of N for constant Z values, or as a function of Z for constant N values enabled suggestions to be made on the work to be undertaken: investigations on Q_α energies, isomeric states, and α branching. The regularity of the curves allowed the (Q_α, ^{112}T) characteristics of unknown Rn, Fr, and Ra isotopes to be predicted. The techniques used to identify these isotopes are recalled: helium jet method and on-line magnetic analysis. The principal characteristics of the on-line mass spectrometer used with the heavy ion beam at Orsay, and the adaptation and installation of the apparatus are described. The absolute cross sections involved in the formation of ^{209}Fr, $^{210+211}$Fr by the bombardment of a Tl target with 89 MeV C ions are given. (France)

14080 (FRNC-TH-125) CHARACTERISTICS OF GLASS NUCLEAR TRACK DETECTORS. APPLICATION TO THE STUDY OF INDUCED FISSION OF MEAN MASS NUCLEI. Lecerf, Marc (Paris Univ., Orsay (France)). 1971. 57p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

An accurate calibration of glass detectors revealed their regions of sensitivity. They were subsequently used to study fission fragments induced by 167-MeV α particles incident on thin targets with Z values between 29 and 79. The number of tracks produced with Au, In, Mo and Cu were counted and the total fission cross sections were determined. The experimental fissilities thus calculated are larger than those predicted by the statistical theory of de-excitation for these nuclei. Measurements on the diameters of the tracks led to total fis-

sion energies, which are in good agreement with values calculated from the liquid drop model. The angular distributions allowed the effective moment of inertia of Au and In to be calculated at the saddle point. The values obtained confirm the diminishing J_o/J_{eff} ratio for values of the fissionability parameter less than 0.67. (France)

14081 (IA-1238) RESEARCH LABORATORIES ANNUAL REPORT, JANUARY-DECEMBER 1970. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). 262p. Dep. NTIS (U. S. Sales Only).

Summaries of research are presented on neutron and reactor physics, nuclear physics, solid state physics and metallurgy, mathematics and theoretical physics and chemistry, high energy and nuclear chemistry, physical and inorganic chemistry, spectroscopy, geochemistry, irradiation of food and industrial products, applications of tracer techniques and radioisotopes, biology and medicines, health physics, nuclear safety, instrumentation and methods for vacuum technology, and the production of radioisotopes and labeled compounds. (J.F.P.)

14082 (IAE-2052) ^{148}Sm NUCLEUS DEEXCITATION FOLLOWING THERMAL NEUTRON CAPTURE. Groshev, L. V.; Demidov, A. M.; Leonov, V. F.; Sokolovskii, L. L. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 16p. (In Russian). INIS.

The gamma-ray spectrum from radiative capture of thermal neutrons by ^{147}Sm nuclei was measured using a single-crystal Ge(Li) spectrometer. A high degree of depletion of the ^{149}Sm sample was achieved by burn-out in an integrated neutron flux of 2.2×10^{20} n/cm^2. The neutron binding energy in ^{148}Sm was 8,141.9 keV. The energies and intensities were determined by isolating the gamma lines from the spectrum. The gamma transition scheme was constructed for ^{148}Sm. The structure of excited states of even-even nuclei of Sm isotopes is discussed for the region $82 < N < 92$. (INIS)

14083 (JINR-E6-6107) NEW NEUTRON-DEFICIENT ISOTOPE ^{92}Ru. Arl't, R.; Bayar, B.; Kratsik, B.; Novgorodov, A. F.; Severa, F.; Tran Thanh Minh; Zaitseva, N. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 13p. Dep. NTIS (U. S. Sales Only).

Both the growth and decay of gamma-lines of the daughter isotope ^{92}Tc and the direct decay of ^{92}Ru were observed. The half-life of the new isotope ^{92}Ru was determined to be $T_{1/2} = (3.16 \pm 0.33)$min. The energies and relative intensities of the ^{92}Ru gamma-rays are: (134.68 ± 0.09) keV (57 ± 8), (213.94 ± 0.11) keV (84 ± 13), (259.41 ± 0.09) keV (100). (auth)

14084 (JINR-P3-6092) DETERMINATION OF THE SPINS OF NEUTRON RESONANCES WITH THE GAMMA-RAY MULTIPLICITY METHOD. Karzhavina, E. N.; Kim Sek Su; Popov, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

Capture gamma-rays were detected by four NaI crystals with the resolution of 100 nsec/m for ^{147}Sm, ^{149}Sm, ^{165}Ho and natural Os. Analysis of the resonance area ratios in time single and coincidence spectra gave two groups of values. It allowed one to get the spin assignment of neutron resonances. (auth)

14085 (JINR-P6-6061) EXCITED STATES OF ^{202}Bi FROM THE DECAY OF ^{202}Po BY ELECTRON CAPTURE. Kusch, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The decay of ^{202}Po, obtained in heavy-ion reactions, was investigated. On the ground of gamma-ray spectra from EC decay of ^{202}Po some conclusions concerning the excited states of ^{202}Bi were drawn. Gamma lines of ^{203}Bi and ^{202}Pb were identified in the observed spectra. (auth)

14086 (JPRS-54305, pp 92-7) MASS-SPECTROMETRIC DETERMINATION OF RELATIVE YIELDS OF XENON ISOTOPES DURING FISSION OF NATURAL URANIUM BY NEUTRONS WITH ENERGY 14.7 MeV. Petrzhak, K. A.; Teplykh, V. F.; Pan'yan, M. G. Translated from Byull. Tsentra Yadern. Dannym; No. 6, 266-71(1969).

A mass spectrometer was used to measure the yield of stable xenon isotopes in the 14.7-MeV neutron fission of ^{238}U. The yield of ^{134}Xe exceeds the smooth-curve yield distribution and is 19% larger than the ^{136}Xe yield. This result verifies earlier work reporting an anomalously high yield of ^{134}Xe. (J.W.R.)

14087 (LBL-500, pp 235-6) NEUTRON PHYSICS EXPERIMENTS WITH ORIENTED NUCLEI. Dabbs, J. W. T. (Oak Ridge National Lab., Tenn.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Three developments have made experiments on spins of compound nuclear states particularly feasible in recent years. These are discussed, and some recent applications are described. (auth)

14088 (LBL-500, pp 237-46) (n,γ) REACTIONS WITH AND NEUTRON-INDUCED FISSION OF ORIENTED NUCLEI. Postma, H. (Groningen Rijksuniversiteit (Netherlands). Natuurkundig Laboratorium). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The first type of experiments concerns gamma emission after capture of either unpolarized or polarized neutrons by oriented nuclei. In the other experiments the directional distribution of fission fragments from aligned ^{233}U, ^{235}U, and ^{237}Np nuclei is studied. These experiments give information about the nature of barrier states of highly deformed nuclei. (auth)

14089 (LBL-500, pp 257-8) SIMULTANEOUS DETERMINATION OF J AND K QUANTUM NUMBERS FROM NEUTRON-INDUCED FISSION OF POLARIZED NUCLEI. Keyworth, G. A.; Seibel, F. T. (Los Alamos Scientific Lab., N. Mex.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

A method is proposed for determining both J and K values from fission of polarized nuclei by a polarized neutron beam. Sizable polarizations and subsequent alignment is achieved in ferromagnetic media placed in a ^{3}He-^{4}He dilution refrigerator. (auth)

14090 (LBL-500, pp 263-6) MEASUREMENT OF THE NUCLEAR QUADRUPOLE MOMENT OF ^{165}Ho BY PROTON SCATTERING FROM AN ALIGNED TARGET. Fisher, T. R. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.); Tabor, S. L.; Watson, B. A. (Stanford Univ., Calif. Dept. of Physics). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The scattering of protons from an aligned ^{165}Ho target (B_2/B_2 (max) $= -0.34$) is analyzed to obtain an estimate of the nuclear quadrupole moment or, equivalently, the nuclear deformation parameter, β. The data are in reasonable agreement with the result $\beta = 0.33$ derived from Coulomb excitation measurements. (auth)

14091 (NYO-4032-69) TWO PARTICLE STATES IN ^{210}Pb, ^{210}Bi, AND ^{210}Po WITH REALISTIC FORCES. Herling, G. H. (State Univ. of New York, Stony Brook. Naval Research Lab., Washington, D. C.); Kuo, T. T. S. (State Univ. of New York, Stony Brook). [1971]. Contract AT(30-1)-4032. 42p. Dep. NTIS.

Two-particle states in ^{210}Pb, ^{210}Bi, and ^{210}Po were calculated with reaction matrix elements deduced from the Hamada-Johnston potential. The inclusion of core polarization is essential for reproducing experimental spectra. Some qualitative aspects of the effective interaction are discussed. (auth)

14092 (OU-LNS-71-11) TWO-NEUTRON TRANSFER REACTIONS ON NUCLEI IN THE TRANSITIONAL REGION. Takemasa, T.; Sakagami, M.; Sano, M. (Osaka Univ. (Japan). Lab. of Nuclear Studies). [1971]. 16p. Dep. NTIS (U. S. Sales Only).

The possibility of coexistence of spherical and deformed states in samarium isotopes is explored by analyzing the experimental data of the two-neutron transfer reactions, and the amount of mixing of the coexisting states and their deformation parameters are determined. (auth)

14093 (RLO-1388-147) SPONTANEOUS FISSION ISOMER EXCITATION ENERGIES FROM THRESHOLD MEASUREMENTS. Vandenbosch, R. (Washington Univ., Seattle). [1971]. 13p. Dep. NTIS.

A modification to an evaporation model employed in the analysis of isomer excitation functions is presented. Isomer excitation energies deduced from the mofified model are shown to be in quantitative agreement with those obtained from a more sophisticated analysis. (auth)

14094 (SC-RR-710399) ELECTRON INDUCED NEUTRON PRODUCTION IN URANIUM TARGETS. Coats, Richard L. (Sandia Labs., Albuquerque, N. Mex.). Jun 1971. 52p. Dep. NTIS.

The Gulf General Atomic Accelerated Pulsed Fast Assembly (APFA) was used to determine the neutron production in uranium and uranium composite targets bombarded by nearly monoenergetic electrons in the energy range 10 to 45 MeV. The study was directed toward obtaining target design parameters for the Electron Driven Nuclear Assembly (EDNA) study program. This report

describes the technique employed and presents the results obtained. (auth)

14095 (UCLA-10-P-18-35) RESEARCH PROGRAM OF THE NUCLEAR CONSORTIUM AT THE UCLA CYCLOTRON LABORATORY. Report AR-6. (California Univ., Los Angeles. Dept. of Physics). Jul 1971. Contract AT(11-1)-Gen-10. 111p. Dep. NTIS.

ANTIMONY-110—beta and electron-capture decay scheme, (E)
ANTIMONY-111—beta and electron-capture decay scheme, (E)
ANTIMONY-112—beta and electron-capture decay scheme, (E)
ANTIMONY-113—beta and electron-capture decay scheme, (E)
ANTIMONY-114—beta and electron-capture decay scheme, (E)
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CALCIUM-40—proton reactions (p,α) and (p,He-3) at 45 MeV, differential cross sections for, (E)
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—deuteron reactions (d,Li-7) at 39 MeV, test of Barshay–Temmer theorem for, (E)
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—deuteron reactions (d,p) with, finite-range DWBA analysis of, (T)
CHARGED PARTICLES—energy deposition in biologically meaningful volumes
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DEUTERIUM—proton reactions (p,2p) at 14.5 MeV, differential cross sections for, (E)
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—alpha elastic scattering by, optical-model and DWBA analyses of, (T)
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HOLMIUM-165—proton reactions (p,np) at 38.5 MeV, particle spectra from, (E)
IRON-57—triton reactions (t,p) at 13 MeV, proton spectra and angular distributions for, (E)
LEAD-208—proton reactions (p,np) at 24.8, 30.5, and 38.6 MeV, proton spectra from, (E)
—energy levels from (p,t) and (t,p) reactions, (E)
LEAD-210—proton reactions (p,t) at 20 MeV, triton spectra from, (E)
LUTETIUM-175—proton reactions (p,np) at 38.5 MeV, particle spectra from, (E)
NITROGEN-15—proton reactions (p,α), (p,He-3), and (p,t) at 45 MeV, particle spectra from, (E)
OXYGEN-16—proton reactions (p,2p) at 45 MeV, p–p angular correlations from, (E)
SCANDIUM-45—proton reactions with differential cross sections for Z = 2 and 3 particles from, (E)
TANTALUM-181—proton reactions (p,np) at 38.5 MeV, particle spectra from, (E)
TERBIUM-159—proton reactions (p,np) at 38.5 MeV, particle spectra from, (E)
THULIUM-169—proton reactions (p,np) at 38.5 MeV, particle spectra from, (E)
TIN-110—energy levels from antimony-110 decay, (E)
TIN-111—energy levels from antimony-111 decay, (E)
TIN-112—energy levels from antimony-112 decay, (E)
TIN-113—energy levels from antimony-113 decay, (E)
TIN-114—energy levels from antimony-114 decay, (E)
TIN-119—proton reactions (p,n) at 28 MeV, angular distributions for, (E)
ZIRCONIUM-91—proton reactions (p,n) at 28 MeV, angular distributions for, (E) (J.W.R.)

14096 NUCLEON TUNNELLING BETWEEN ^{16}O AND ^{208}Pb. Barnett, A. R. (Univ. of Minnesota, Minneapolis); Phillips, W. R.; Buttle, P. J. A.; Goldfarb, L. J. B. Nucl. Phys.; A176: No. 2, 321-37(1971).

Measurements were made of differential cross sections for neutron and proton tunneling reactions using ^{16}O ions of bombarding energy 69.1 MeV incident on a ^{208}Pb target. The reactions, which lead to particle states in ^{209}Bi and hole states in ^{207}Pb, were analyzed using the DWBA. The tunneling takes place well below the Coulomb barrier, and the distorted waves used in the calculation were Coulomb functions. Information was derived concerning the bound-state well parameters in the ^{208}Pb region and the corresponding spectroscopic factors. The angular distributions are well fitted, particularly for proton transfer, and the spectroscopic factors are consistent with simple shell-model predictions, using a reasonable set of bound-state well parameters. (auth)

14097 PROTON STATES IN ^{191}Ir AND ^{193}Ir POPULATED BY THE (^{3}He,d) AND (α,t) REACTIONS. Price, R. H.; Burke, D. G.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A176: No. 2, 338-62(1971).

The proton states in ^{191}Ir and ^{193}Ir were studied using (^{3}He,d) and (α,t) reactions. The beams of 28-MeV ^{3}He and ^{4}He particles were obtained from the University of Rochester model MP tandem Van de Graaff accelerator, and the reaction products were analyzed with an Enge split-pole magnetic spectrograph. Transfer l values were obtained from cross-section ratios of the two stripping reactions, and spectroscopic factors were extracted using DWBA calculations. The present results reveal that the extreme single-particle shell model does not predict the observed level structure in the iridium region, whereas the Nilsson model appears to be fairly successful. It has been shown that Coriolis mixing must be included in the model, with matrix elements of half strength providing good agreement with experiment. The $3/2^+[402]$, $11/2^-[505]$, $5/2^+[402]$, $1/2^-[541]$, and $1/2^-[530]$ Nilsson orbitals are identified in both iridium isotopes. The $K_0 - 2$ and $K_0 + 2$ γ vibrations based upon the ground state appear to be mixed with the $1/2^+[400]$ and $7/2^+[404]$ orbitals, respectively. The $1/2^+[660]$ orbital may have been located, but with appreciable fragmentation of its strength. (auth)

14098 GAMMA RAYS FOLLOWING μ^- CAPTURE IN HEAVY ELEMENTS. Earle, E. D.; Bartholomew, G. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl Phys.; A176: No. 2, 363-80(1971).

The spectra of γ rays >0.6 MeV following the capture of μ^- in Bi, $^{208}Pb(NO_3)_2$, radiogenic Pb, Au, Ag, and Zr targets were measured with a large NaI detector, and the intensity and energy distributions were deduced. The spectra are distinguished by a few resolved lines at low energies and, for Bi, radiogenic Pb, and Au, by a distinct group of γ rays centered at 4.2 MeV. In gross shape, the spectra resemble those following inelastic neutron scattering. There is no prominent γ-ray anomaly near 5.5 MeV similar to that in the spectra following neutron transfer reactions in the same mass region. The average number of γ rays per μ capture and mean excitation energy prior to γ emission are estimated. (auth)

14099 GAMMA–GAMMA DIRECTIONAL CORRELATIONS IN ^{140}Ce. Wiedenbeck, M. E.; Raeside, D. E. (Univ. of Michigan, Ann Arbor). Nucl. Phys.; A176: No. 2, 381-9(1971).

Directional correlation measurements were performed on six γ-ray pairs occurring in the de-excitation of ^{140}Ce. Of these, two are 1–3 correlations with an unobserved intermediate γ ray. Both NaI(Tl)–Ge(Li) and Ge(Li)–Ge(Li) detector systems were used. The following mixing ratios were deduced for the 329-, 433-, 487-, 752-, 816-, and 868-keV transitions: δ(329; D, Q) = 0.018 ± 0.007, δ(433; D, Q) = 0.36 ± 0.02 or −0.14 ± 0.03, δ(487; Q, O) = −0.002 ± 0.007, δ(752; D, Q) = − 0.33 ± 0.03, δ(816; D, Q) = 0.031 ± 0.005, $-0.09 < \delta(868; D, Q) < 0.10$. (auth)

14100 COULOMB EXCITATION OF ^{139}La. Graetzer, R.; Bouley, A. C.; Plesko, G. (Pennsylvania State Univ., University Park). Nucl. Phys.; A176: No. 2, 433-48(1971).

Energy levels of ^{139}La were populated by Coulomb excitation with 12-MeV α particles. Alpha particles scattered at 100°, 120°, and 160° from thin $^{139}La_2O_3$ targets were analyzed in a magnetic spectrograph. In a complementary experiment with thick La foils, de-excitation γ rays following Coulomb excitation with 4.5-MeV protons and 4- to 12-MeV α particles were studied with a 2-cm^3 and a 50-cm^3 Ge(Li) detector. Levels were found at 1218.7, 1257.2, 1421.4, 1538.7, 1578.9, and 1683.8 keV (with uncertainties of ±1 keV), in addition to the well-known 166-keV level. If electric quadrupole excitation is assumed, the corresponding B(E2) values for excitation are 1.65, 0.45, 0.62, 2.6, 2.4, and 0.43 single-particle units. In contrast to an earlier Coulomb excitation experiment, no evidence was found for levels between 166 and 1218 keV. The level energies determined here agree well with those found by a variety of other techniques. The experimental results are in satisfactory accord with several recent theoretical calculations. (auth)

14101 TRIPLE GAMMA CASCADE STUDIES IN ^{182}W FROM THE DECAY OF ^{182}Ta. Pande, U. S.; Singh, B. P. (Univ. of Roorkee, India). Indian J. Phys.; 44: No. 5, 300-7(May 1970).

Triple gamma angular-correlation studies were done on ^{182}W from the decay of ^{182}Ta. The correlation studies were done with two NaI (Tl) detectors in the plane of the table and one perpendicular to it. The detector for the third gamma ray of the cascade was kept at various angles. The correlation functions thus obtained are as follows: For 68 keV–1122 keV–100 keV cascade, $W(\theta) = 1 + (0.276 \pm 0.0255) P_2 (\cos \theta) + (0.0021 \pm 0.0322) P_4 (\cos \theta)$. For 152 keV–1122 keV–100 keV cascade, $W(\theta) = 1 - (0.131 \pm 0.068) P_2 (\cos \theta) + (0.124 + 0.082) P_4 (\cos \theta)$. The multipolarities of the 68-keV, 100-keV, 152-keV, and 1122 keV gamma rays are discussed. (auth)

14102 ALPHA REDUCED WIDTHS FOR SUPERHEAVY NUCLEI. Carjan, N.; Holan, S.; Sandulescu, A.; Sabac, C. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 7, 811-14(1971).

In order to see if shell effects are important in the alpha decay of superheavy nuclei, the alpha reduced widths were calculated for all even–even and even–odd nuclei in the region Z = 114. It is concluded that the shell structure in the region Z = 114, N = 184 can give deviations from the Geiger–Nuttall law of up to a factor of 10. Alpha-decay predictions for neighboring nuclei based only on binding energies can be corrected for nuclear structure effects by using the graphs given. (3 figures, 2 tables) (R.W.R.)

14103 ENERGY LEVELS OF ^{92}Zr. Azuma, Toshio; Sato, Yuji. Annu. Rep. Radiat. Center Osaka Prefect.; 11: 53-4 (1970).

The γ-rays from ^{92}Zr are measured by 40cc Ge(Li) and 2 × 2" NaI detectors. In the single spectrum, there are three γ-rays of 930, 904 and 1,836 keV. But in the spectrum gated with 930 keV γ-ray, two γ-rays of 564 and 448 keV are observed. (auth)

14104 INTERMEDIATE ENERGY PHOTOFISSION IN TANTALUM, GOLD, AND LEAD. Kroon, I.; Forkman, B. (Lund Inst. of Tech., Sweden. Univ. of Lund, Sweden). Nucl. Phys.; A179: No. 1, 141-52(1972).

The angular distributions of fragments in photofission of gold and lead have been measured in the bremsstrahlung energy range 250 to 1000 MeV with the aid of glass detectors. In the whole energy interval the angular distributions are nearly isotropic in the laboratory system with a small but significant forward peaking which increases by decreasing mass number. This anisotropy is supposed to be an effect of nuclear motion. By measuring the forward-to-backward ratios of emitted fission fragments for tantalum, gold and lead it is concluded that the anisotropy is increasing only slightly with increasing bremsstrahlung energy. (auth)

14105 INVESTIGATION OF THE LOW-ENERGY SPECTRUM IN ^{93}Nb. Kregar, M.; Seaman, G. G. (Kansas State Univ., Manhattan). Nucl. Phys.; A179: No. 1, 153-60(1972).

Coulomb excitation of low-energy levels in ^{93}Nb with oxygen ions has been studied at incident beam energies of 25 to 42 MeV. The most intense γ-rays observed can be assigned to members of a multiplet of a $g_{9/2}$ proton coupled to the ^{92}Zr core. Energy-level measurements and B(E2) values obtained (in units of $e^2 \times 10^{-52} cm^4$) are as follows: 744.7 ± 0.3 keV, 180 ± 13; 809.3 ± 0.3 keV, 167 ± 12; 950.5 ± 0.3 keV, 247 ± 17; 979.0 ± 1.0 keV, 127 ± 11; 1084.0 ± 1.0 keV, 21.9 ± 2.6. Excitation probabilities and spin assignments are discussed in terms of the weak coupling model. (auth)

14106 DECAY SCHEMES OF ^{94}Y AND ^{95}Y AND γ-RAYS OBSERVED IN THE DECAY OF ^{96}Y. Hontzeas, S.; Marsden, D. A. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Nucl. Phys.; A179: No. 1, 193-204(1972). (AECL–4036).

Active yttrium was separated from ^{235}U fission products and the decay of ^{94}Y, ^{95}Y and ^{96}Y to the levels of ^{94}Zr, ^{95}Zr and ^{96}Zr, respectively, has been studied with the aid of a 17 cm^3 Ge(Li) detector. Gamma-ray energies and intensities were accurately determined. In the decay of ^{94}Y four new transitions at 1232.78 ± 0.35, 1324.97 ± 0.35, 1363.48 ± 0.35 and 2467.00 ± 2.75 keV were observed. The data obtained support the level scheme proposed for ^{97}Zr by Knight et al. and that deduced from more recent reaction data. Evidence supporting the location of the 0^+ excited state at 1300 keV is presented. Branching ratios are calculated and a modified level scheme for ^{94}Zr is proposed. In the decay of ^{95}Y the energies of 13 γ-rays, previously identified with the decay of this nuclide, have been accurately measured and are presented in a partial level scheme for ^{95}Zr. The data obtained in this work support the level structure deduced from reaction data by Cohen and Chubinsky and by other workers. New γ-transitions at 550.10 ± 0.23, 1723.30 ± 0.90 and 1805.0 ± 1.0 keV were measured in the decay of ^{96}Y. (auth)

14107 DECAY OF ^{121}Xe. Muennich, F. (CERN, Geneva); Kugler, H.; Schrader, H.; Stippler, R. Nucl. Phys.; A179: No. 1, 205-222(1972).

The decay scheme of 40 min ^{121}Xe has been investigated using isotopically separated samples produced by the ISOLDE facility at CERN. A total number of 244 γ-transitions have been observed in this decay; 217 of them have been placed in a level scheme involving 56 excited states in ^{121}I. Most of these levels are deduced from the results of γ–γ coincidence experiments with two Ge(Li) detectors. (auth)

14108 TECHNIQUES OF SEPARATION OF ^{134}Cs ISOMERS FORMED IN FISSION OF ^{238}U BY ALPHA PARTICLES OF MEDIUM ENERGY. Fleury, A. (CEN, Bordeaux); Hamon, F.; Nguyen Long Den J. Mass Spectrom. Ion Phys.; 7: No. 3, 221-5(Sep 1971).

The ratio of ^{134}Cs isomers produced in the fission of ^{238}U by alpha particles of energies 40 to 130 MeV was measured. Two experimental techniques were used to separate ^{134}Cs from the other fission products: a physical method by means of an electromagnetic mass separator and a radiochemical method. The two methods are compared. Their results are coherent, and the isomer ratio is found not to vary with bombarding energy. (auth)

14109 BETA-GAMMA CIRCULAR-POLARIZATION CORRELATION IN THE DECAY OF ^{141}Ce. Schmidt, V. (Institut fuer Kernphysik, Muenster, Ger.). Nucl. Phys.; A180: No. 2, 376-84(1972).

The $\beta\gamma_{cp}$ correlation of ^{141}Ce has been investigated using the Compton-backscattering method and a Ge(Li) detector for the determination of the circular polarization of the γ rays. Beta particles are detected by a silicon surface-barrier detector. The measured asymmetry coefficient is $\omega = -0.26 \pm 0.12$. This value is independent of Rayleigh-scattering influences. A discussion of the result on the basis of the ξ-approximation formalism yields the two ranges of the nuclear matrix element ratio X: $0.3 \leq X \leq 0.7$ and $2.1 \leq X \leq 7.1$. Assuming pure shell-model states it is possible to interpret the result as a $(2f_{5/2})_{neutron}$ to $(1g_{7/2})_{proton}$ β-transition which favors for the zero-order matrix element ratio Λ_0 a value between 1.28 and 1.65. (auth)

14110 ELASTIC AND INELASTIC PROTON SCATTERING FROM ^{116}Cd. Deye, J. A.; Robinson, R. L.; Ford, J. L. C. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A180: No. 2, 449-71(1972).

The differential cross sections for elastically and inelastically scattered 12 MeV protons from ^{116}Cd have been measured for 18 groups to levels below ≈2.8 MeV. The elastic scattering was fitted by searching for the best parameters of an optical model. The observed cross sections for excitation of the one-phonon 2^+ and 3^- states were compared to the predictions of both the DWBA and coupled-channel theories. Distortion parameters were extracted and compared to those determined from E2 transition probabilities. The coupled-channel theory was used to calculate cross sections for the one-octupole-one-quadrupole and two-quadrupole phonon states. States at 2.041, 2.115, and 2.296 MeV were fitted by means of the 1^-, 3^-, or 5^-, and 3^- octupole-quadrupole coupled-channel calculations, respectively. Fits to the two-quadrupole phonon-like states were obtained by assuming an admixture of the one-phonon state in their description. The amplitudes of these admixed wave functions were calculated from both the proton scattering and Coulomb excitation experimental results and it was found that the one-phonon amplitudes, especially for the second 2^+ states, are large. The results for ^{116}Cd are compared with those obtained from inelastic proton scattering and Coulomb excitation of other nuclei in this mass region to determine systematic trends. (auth)

14111 SINGLE-PARTICLE DENSITY DISTRIBUTIONS OF SILVER IN THE EXTREME NUCLEAR SURFACE. Brock, B. (Pahlavi Univ., Shiraz, Iran). Nucl. Phys.; B36: No. 2, 345-48 (1972).

The single-particle wave functions of ^{107}Ag beyond the nuclear potential are calculated exactly. It is shown that the centrifugal barrier cannot be neglected in the region of the last classical turning point of the nuclear density. Thus K^- meson absorption by emulsions cannot be explained by the difference between the effect of the Coulomb barrier in heavy and light emulsion nuclei. (auth)

14112 GIANT DIPOLE RESONANCE IN N = 82 NUCLEI. Beil, H. (CEN, Saclay, France); Bergere, R.; Carlos, P.; (and others). Nucl. Phys.; A172: No. 2, 426-36(1971).

Total photoneutron cross sections for Ba, ^{139}La, Ce, ^{141}Pr, and Nd, using a monochromatic photon beam are obtained by measuring directly and simultaneously the partial photoneutron cross sections $\sigma(\gamma,n) + \sigma(\gamma,pn)$ and $\sigma(\gamma,2n)$. In particular the modulation of the giant dipole resonance of ^{141}Pr is compared with previously published results. A tentative analysis of the observed structure within the framework of the particle-hole as well as the collective models is also attempted. (auth)

14113 SEARCH FOR ATOMIC AFTER-EFFECTS OF THE β-DECAY OF ^{160}Tb IN INSULATING AND SEMICONDUCTING COMPOUNDS. Lopiparo, P. C.; Rasera, R. L.; Caspari, M. E. (Univ. of Pennsylvania, Philadelphia). Nucl. Phys.; A178: No. 2, 577-92(1972).

The hyperfine fields at ^{160}Dy nuclei immediately following the β^- decay of ^{160}Tb have been examined at room temperature in anhydrous terbium fluoride and in $Eu_{1-x}Tb_xS$ for several values of x. Integral-rotation perturbed angular correlation (PAC) measurements on cascades proceeding through the 2.9 nsec first excited state show that the paramagnetic correction factor β is close to the free-ion value for the daughter Dy^{3+} ion, and is independent of the number of available lattice electrons over the entire range of conductivity from semimetal to ionic insulator. Calculations based on a simple model show that the source of the electrons needed for atomic-shell recovery may be trace impurities at a level available even in the purest of insulating materials. At room temperature in zero applied magnetic field, the character of the fluctuating hyperfine field at the ^{160}Dy nucleus is found via time-differential and time-integral PAC measurements to be principally magnetic in character, arising from the rapid relaxation of the 4f shell. (auth)

14114 ABSOLUTE γ-RAY TRANSITION PROBABILITIES IN DOUBLY ODD DEFORMED NUCLEI. Andrejtscheff, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys.; A178: No. 2, 563-76(1972).

A compilation is presented which contains data about the available absolute electromagnetic transition probabilities between two-quasiparticle states in doubly odd deformed nuclei of medium-mass number. Comparisons of dipole transitions between the same Nilsson states in doubly odd and odd-mass nuclei are performed on the basis of Weisskopf and Nilsson hindrance factors. Some level assignments are critically considered. Octupole transitions are also systematized. (auth)

14115 ELASTIC SCATTERING OF POLARIZED PROTONS FROM NUCLEI NEAR A = 200 BETWEEN 11 AND 14 MeV. Rathmell, R. D.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys.; 178: No. 2, 458-68(1972).

Differential cross-section and polarization measurements were made between 30° and 150° for the elastic scattering of protons from ^{181}Ta and ^{209}Bi at 10.8 MeV, from ^{197}Au, ^{207}Pb, ^{208}Pb, and ^{209}Bi at 13 MeV, and from ^{181}Ta and ^{197}Au at 13.8 MeV. In addition the polarization was measured in steps of 300 keV or less near 140° for ^{197}Au from 8 to 14 MeV and for ^{181}Ta from 9 to 14 MeV. The results were analyzed using the optical model. Good fits to the cross-section and polarization measurements were obtained. (auth)

14116 M AND N SUBSHELL RATIOS OF THE 2.17 keV TRANSITION IN ^{99m}Tc. Lacasse, W. M.; Hamilton, J. H. (Vanderbilt Univ., Nashville). Nucl. Phys.; A171: No. 3, 641-6(1971).

The $M_2/M_3/M_{4+5}/\Sigma N$ subshell ratios of the 2.17 keV E3 transition in ^{99m}Tc have been measured with the Vanderbilt iron-free, double-focusing spectrometer. The experimental results obtained for these ratios are 56.4 ± 2/100/47.6 ± 2/28.6 ± 5 which compare favorably with the theoretical ratios of Hager and Seltzer. The energy of the transition was measured to be 2.17 ± 0.01 keV. (auth)

14117 FRAGMENT KINETIC ENERGIES IN MeV NEUTRON-INDUCED FISSION OF ^{232}Th. Holubarsch, W.; Pfeiffer, E.; Goennenwein, F. (Univ., Tuebingen, Ger.). Nucl. Phys.; A171: No. 3, 631-40(1971).

In a two-parameter experiment the kinetic energies of fission fragments from the reaction ^{232}Th(n,f) were measured with semiconductor detectors. The neutron energies were 1.90, 2.97, and 4.81 MeV. From the data, mass and energy distributions along with the correlations between energy and mass were calculated. The mass distributions exhibit the well-known double-humped curve, with the peak-to-valley ratio decreasing from 510/1, 122/1 to 45/1 for neutron energies E_n = 1.90, 2.97, and 4.81 MeV, respectively. A fine structure is observed in the mass yield at primary heavy fragment mass numbers A_H^* = 134 and 141. The mean total primary fragment kinetic energy $\bar{E}_K^*$ increases from 169.0 ± 2.0, 169.7 ± 2.0 to 170.4 ± 2.0 MeV for neutron energies 1.90, 2.97 and 4.81 MeV, respectively. The errors given include the estimated systematic error, the statistical errors being in the order of 0.05 MeV. The increase in kinetic energy with excitation energy seems to be peculiar for ^{232}Th. It is seen for all masses, except perhaps for the heavy mass numbers A_H^* = 123 through 126 in the transition region between symmetric and asymmetric mass splits. The results are discussed in terms of channel effects at the saddle point and shell effects at the scission point. (auth)

14118 EFFECT OF WIDE SCATTERING RESONANCES ON NEUTRON MULTIGROUP CROSS SECTIONS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.: 47: No. 1, 29-39(Jan 1972).

The influence of wide scattering resonances on group-averaged uranium and plutonium resonance cross sections and on group elastic removal cross sections is examined; the consequences for a Bondarenko-type LMFBR multigroup cross-section scheme are discussed. An analytical expression is derived for a constant effective cross section which adequately accounts for the sodium resonance in the computation of group-averaged uranium and plutonium resonance cross sections. Analytical expressions are derived for the group elastic removal cross sections, also. These latter are superior to the Bondarenko prescriptions in that they account for the location of a scattering resonance within a group and thus account for both the relative probability that a neutron scattered in the resonance will be scattered out of the group and for the relative flux shape within the group. The composition dependence of these expressions is shown to be characterized by a single parameter. Numerical results are presented for compositions that are typical of proposed LMFBRs. (auth)

14119 FRAGMENT ANGULAR DISTRIBUTIONS OF THE NEUTRON-INDUCED FISSION OF ^{230}Th. Yuen, G.; Rizzo, G. T.; Behkami, A. N.; Huizenga, J. R. (Univ. of Rochester, N. Y.). Nucl. Phys.; A171: No. 3, 614-24(1971).

Fission-fragment angular distributions were measured for the fission of ^{230}Th induced with monoenergetic neutrons of energies 682, 715, 730, and 740 keV and energy resolution 5 keV, and energies of 750 and 1000 keV and energy resolution 20 keV. The unusual peak in the excitation function of the ^{230}Th(n,f) reaction for neutron energies in the vicinity of 720 keV is interpreted in terms of a vibrational-mode resonance state in a potential well of a two-humped fission barrier. Evidence is presented to show that the resonance has $K = \frac{1}{2}$. Theoretical fits to the fission cross sections and angular distributions are shown for both parities. (auth)

14120 NUCLEAR STRUCTURE STUDY WITH THE ^{94}Mo(p,t)^{92}Mo REACTION. Moalem, A. (Tel-Aviv Univ., Ramat-Aviv, Israel); Moinester, M. A.; Auerbach, N.; Alster, J.; Dupont, Y. Nucl. Phys.; A177: No. 1, 145-60(1971).

The angular distributions of states excited in the reaction ^{94}Mo(p,t)^{92}Mo at E_p = 40 MeV are measured. Values of the angular momentum transfers L and the spectroscopic enhancement factors are extracted by means of a zero-range DWBA calculation. Several new J^π assignments are made. The strongly excited states are attributed to 1p-1h and 2p-2h neutron states. Lower-lying proton configuration states are weakly excited. Good agreement is obtained with a calculation which describes the excitation of these proton states through particular components in the ^{94}Mo g.s. wave function. The long predicted 0^+ state in ^{92}Mo at 2.5 MeV is identified. A 0^+ pairing vibrational state has been located at 3.85 MeV. The possible existence of 2^+, 4^+, 3^-, and 5^- pairing vibrational states is discussed. (auth)

14121 FRAGMENTATION OF ONE-HOLE STATE STRENGTHS IN THE ^{208}Pb(p,d)^{207}Pb REACTION BY HOLE-CORE COUPLING STATES. Smith, S. M. (Univ. of Maryland, College Park); Roos, P. G.; Moazed, Cyrus; Bernstein, A. M. Nucl. Phys.; A173: No. 1, 32-48(1971).

In the investigation of the ^{208}Pb(p,d)^{207}Pb reaction at an incident energy of 41 MeV many weak levels were observed in addition to the expected strong excitation of the levels corresponding to the six predominantly one-neutron-hole states. The existence of some of these weakly excited levels can be explained by the presence of [hole × ^{208}Pb(core)] coupling states in ^{207}Pb. Predictions from weak coupling model calculations indicate that these states with the correct spin and parity can fragment some of the one-hole states significantly. The observation of an l = 3 level at 4.52 MeV with 10% of the $2f_{\frac{5}{2}}$ hole state strength is consistent with these predictions. A level observed at 3.29 MeV and assigned $j^\pi = \frac{1}{2}^+$ is believed to be a predominantly $(2f_{\frac{5}{2}}^{-1} \times 3^-)$ coupling state. Its strength is consistent with that predicted for the direct excitation of a fragment of the $3s^{-1}$ state. The fragmentation (>4%) of the predominantly $1i_{\frac{13}{2}}$ and $1h_{\frac{9}{2}}$ hole states is also predicted. Since the present reaction is relatively less sensitive to states with l-values of 5 and 6, these fragments could not be reliably identified from among the levels excited. (auth)

14122 INVESTIGATION OF THE POPULATION OF THE SHAPE ISOMER ^{236m}U THROUGH THE (d,p) REACTION. Pedersen, J.; Rasmussen, B. (Univ. of Copenhagen). Nucl. Phys.; A178: No. 2, 449-57(1972).

A measurement of the proton spectrum from the ^{238}U(d,p) reaction leading to the population of the 110 ns shape isomer in ^{236}U is reported. It is shown that the data can be explained within a two-humped fission-barrier model assuming a population of the class I states through the direct (d,p) reaction and successively a decay of

these states via the compound motion. Comparison between the observed cross section for delayed fission and the calculated cross section for production of the isomeric state indicates that the main decay mode of the isomeric state is a γ-de-excitation back to the normally deformed ground state. (auth)

14123 GIANT DIPOLE RESONANCE IN THE TRANSITION REGION FOR THE NEODYMIUM ISOTOPES. Carlos, P.; Beil, H.; Bergere, R.; Lepretre, A.; Veyssiere, A. (Centre d'Etudes Nucleaires, Sacaly, France). Nucl. Phys.; A172: No. 2, 437-48 (1971).

The giant dipole resonances of ^{142}Nd, ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd, ^{150}Nd, are studied with a monochromatic photon beam by measuring simultaneously partial photonuclear cross sections $\sigma(\gamma,n) + \sigma(\gamma,pn)$ and $\sigma(\gamma,2n)$. Spreading of the dipole strength as Nd nuclei become softer followed by splitting into two distinct dipole modes for ^{150}Nd was observed. An interpretation using the extended collective model is attempted. (auth)

14124 DECAY OF ^{164}Tb TO LEVELS OF ^{164}Dy. Gujrathi, S. C.; D'Auria, J. M. (Simon Fraser Univ., Burnaby, B. C.). Nucl. Phys.; A172: No. 2, 353-94(1971).

A spectroscopic study of the decay of ^{164}Tb to the levels of the permanently deformed nuclide ^{164}Dy was performed with the sources produced from the (n,p) reactions on both enriched and natural dysprosium targets. Employing both β- and γ-spectrometers, singly and in coincidence, a decay scheme is proposed with 25 levels in ^{164}Dy populated up to an energy of 3014 keV incorporating over 100 γ-rays. The half-life was measured to be 2.9 ± 0.1 min with a Q_β-deduced to be 3.8 ± 0.15 MeV. The results are discussed in terms of the unified model and the two-quasiparticle model, and further it is suggested that at least four levels in ^{164}Dy could correspond to at least two-proton quasiparticle states. (auth)

14125 LARMOR PRECESSION OF THE FIRST ROTATIONAL LEVEL OF ^{181}Ta. Keszthelyi, L. (McMaster Univ., Hamilton, Ont.); Cameron, J. A.; Santry, D. C. Can. J. Phys.; 49: No. 21, 2646-50(1 Nov 1971).

Perturbed angular correlation measurements were made on the decay of ^{181}Hf implanted in iron. The average integral rotation angle for the 136 keV $^9/_2$+ state of ^{181}Ta is $\omega\tau = 0.051 \pm 0.004$ rad. For the internal field on Ta in iron of 640 kOe, this gives a nuclear g factor of 0.27 ± 0.04. Alternative explanations of the small rotation are discussed. The E2/M1 mixing ratio of the 136 keV transition was found to be $\delta = -0.44 \pm 0.04$. (auth) (Canada)

14126 VIBRATIONAL STATES IN EVEN WOLFRAM NUCLEI. Guenther, C.; Kleinheinz, P.; Casten, R. F.; Elbek, B. (Niels Bohr Inst., Copenhagen Nucl. Phys.; A172: No. 2, 273-97(1971).

The even wolfram isotopes ^{180}W, ^{182}W, ^{184}W, and ^{186}W have been studied by inelastic scattering of 12 MeV deuterons. In the four nuclei the 2^+ state of the γ-vibration and the 3^- rotational member of the low-lying K = 2 octupole vibration are strongly excited. Except for ^{180}W, the 0^+ and 2^+ members of K = 0 bands have been observed. Several further states at higher excitation energies are populated with appreciable cross section. A phenomenological analysis of the coupling of the positive-parity collective excitations in ^{182}W and ^{184}W is given. The B(E3) value for excitation of the 3^- member of the octupole band in ^{182}W is obtained from an analysis of the γ-de-excitation of this band. Existing experimental results for the vibrational excitations in the wolfram nuclei are compared with theoretical predictions. The data are in accord with the expectations for strongly deformed nuclei. (auth)

14127 FAST NEUTRON TOTAL AND SCATTERING CROSS SECTIONS OF ^{240}Pu. Smith, A. B.; Lambropoulos, P.; Whalen, J. F. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 47: No. 1, 19-28(Jan 1972).

Experimental fast neutron total cross sections and elastic and inelastic scattering cross sections of ^{240}Pu are reported. The total cross sections are measured from neutron energies of 0.1 to 1.5 MeV in increments of ~25 keV. The scattering cross sections are measured at ≲50-keV intervals from incident neutron energies of 0.3 to 1.5 MeV. The inelastic neutron excitation cross sections of states at 42 ± 5, 140 ± 10, 300 ± 20, 600 ± 20, and 900 ± 50 keV are measured. The experimental results are discussed in the context of the optical, compound-nucleus and direct-reaction nuclear models including the effects of resonance width fluctuations and the fission process. The measured results are compared with the corresponding quantities in the evaluated nuclear data file ENDF/B. (auth)

14128 COMPARISON OF CALCULATED AND MEASURED YIELDS OF NEUTRON-ENERGY-DEPENDENT CAPTURE GAMMA RAYS FROM ^{238}U. Booth, R. S. (Oak Ridge National Lab., Tenn.); White, J. E.; Penny, S. K.; Yost, K. J. Nucl. Sci. Eng.; 47: No. 1, 8-18(Jan 1972).

The gamma-ray energy spectra resulting from neutron capture in ^{238}U were calculated using the gamma-ray cascade code DUCAL for incident neutrons in the energy range $0.0 \leq E \leq 1.1$ MeV. The overall spectral shapes generated for thermal and epithermal neutron capture agree quite favorably with an integral measurement. Absolute comparisons of the generated spectra with differential capture yield measurements exhibit general agreement. Variations in the spectral shape with neutron energy are noticeable above 3.0 MeV. (auth)

14129 ^{132}I DECAY. Weiss, Beatrice (Univ., Nice). Compt. Rend., Ser. B; 273: No. 14, 639-41(4 Oct 1971). (In French).

The γ radiation accompanying the disintegration of ^{132}I was studied, after the ^{132}I had been chemically isolated. A 28 cm^3 Ge(Li) detector was used. More than 24 new gamma transitions were observed. The data suggest the existence of several new excited levels of ^{132}Xe. (France)

14130 STUDY OF γ-RAY EMISSION IN THE DECAY OF ^{228}Ac USING COINCIDENCE TECHNIQUES. Dalmasso, Josette; Hachem, Ahmed; Risselada, Thys; Maria, Henriette (Univ., Nice). Compt. Rend., Ser. B; 273: No. 12, 509-12(20 Sep 1971). (In French).

Measurements of line intensities in the coincidence spectra obtained for the gamma radiation emitted by ^{228}Ac enabled the position of certain γ transitions of the ^{228}Th level scheme to be precisely determined. The $\gamma-\gamma$ coincidence spectra were studied in the 129, 209, 270, 330, 409, 463, 510, 795, 900 and 968 keV regions (20 keV accuracy) of the scintillation spectrum, using both NaI(Tl) and Ge(Li) detectors. (France)

14131 COULOMB EXCITATION OF $^{182\ 184\ 186}$W, $^{187\ 188\ 190\ 192}$Os AND $^{192\ 194\ 196\ 198}$Pt WITH PROTONS, ^{4}He AND ^{16}O IONS. Milner, W. T.; McGowan, F. K.; Robinson, R. L.; Stelson, P. H.; Sayer, R. O. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A177: No. 1, 1-32(1971).

Coulomb excitation of the first 2^+ states was produced in ^{186}Os with 3 to 5 MeV ^{4}He ions, ^{188,190,192}Os with 4.56 to 5.08 MeV protons, and $^{192-198}$Pt with 4.5 MeV protons and 43.75 MeV ^{16}O ions. Values of B(E2, O → 2) have been extracted with an absolute uncertainty of ±9% for ^{186}Os, ±7% for $^{188-192}$Os and ±5–6% for $^{192-198}$Pt. Coulomb excitation of second 2^+ states was produced in $^{182-186}$W with 5 MeV protons, 14 and 15 MeV ^{4}He ions and 45.5 MeV ^{16}O ions, and in $^{186-192}$Os with 5 MeV protons, 15 MeV ^{4}He ions and 42, 45.1 and 45.4 MeV ^{16}O ions. Excitation of higher 2^+ states at 1257, 1386 and 1286 keV was effected in ^{182,184,186}W with 15 MeV ^{4}He ions. Values of B(E2, 0 → 2′), B(E2, 2 → 2′), B(M1, 2′ → 2), and $\delta = \langle 2||E2||2'\rangle/\langle 2||M1||2'\rangle$, and the transition branching ratio $T(2' \rightarrow 2)/T(2' \rightarrow 0)$ are reported for second and higher 2^+ states. Values of B(E2, 2 → 4) have been obtained for $^{182-186}$W and $^{186-192}$Os from direct Ge(Li) spectra using 15 MeV ^{4}He ions and 42–45.5 MeV ^{16}O ions and from ^{16}O-γ coincident (NaI) spectra using 42–45.5 MeV ^{16}O ions, and for ^{194,196}Pt from direct Ge(Li) spectra using 43.75 MeV ^{16}O ions. Values of B(E2, 4 → 6) for ^{182,184,186}W were also extracted from the ^{16}O-γ data. Data analysis was carried out using first-order quantal perturbation theory in the case of proton and ^{4}He ion experiments. First- and second-order semi-classical perturbation theory and the multipole-Coulomb-excitation program of De Boer and Winther as augmented by Sayer was used in analyzing the ^{16}O ion data. The De Boer–Winther program was also used to estimate multiple excitation corrections for the ^{4}He ion data. The results are compared to recent results of other workers and to the pairing-plus-quadrupole model calculations of Kumar and Baranger as well as to the predictions of the more simple phenomenological models. (auth)

14132 ISOBARIC ANALOGUE RESONANCES IN ^{141}Pr BY ELASTIC AND INELASTIC PROTON SCATTERING FROM ^{140}Ce. Marquardt, N.; Rauser, P.; Von Brentano, P.; Wurm, J. P.; Zaidi, S. A. A. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A177: No. 1, 33–69(1971).

Excitation functions and angular distributions for the elastic and inelastic proton scattering from ^{140}Ce have been measured. In the case of the elastic scattering, excitation functions have been taken in the energy range from 8.80 to 12.00 MeV in steps of 5, 10 or 20 keV at the following scattering angles: 90.0, 103.8, 122.6, 140.8, 149.4 and twice at 170.0° whereas for the reaction ^{140}Ce(p,p$_1$), the energy range has been from 9.50 MeV to 11.70 MeV at the eight scattering angles: 50, 60, 70, 130, 140, 150, 160 and 170°. Sharp resonances in the compound nucleus ^{141}Pr corresponding to the isobaric analog states of the low-lying levels in ^{141}Ce up to an excitation energy of 1.8 MeV have been observed in the elastic and inelastic channel. An analysis of the excitation functions of the (p,p$_0$) reaction and of the excitation functions and angular distributions of the (p,p$_1$) reaction for all measured scattering angles has been performed. The results of the analysis are a set of resonance parameters, such as resonance-energy,

total width, proton partial width, parity and angular momentum of the resolved resonances observed in the highly excited compound nucleus. Good agreement has been obtained between the (p,p_0) and (p,p_1) experiments and with the data of the (d,p) reaction on the same target nucleus. The inelastic scattering shows clear indications of a direct interaction amplitude coherently superimposed on the predominant Breit–Wigner resonance amplitude. Finally, Coulomb displacement energies were calculated and the resulting nuclear radii were compared with other independent measurements of the nuclear radius. (auth)

14133 LEVELS IN ^{207}Po POPULATED IN THE DECAY OF ^{207}At. Jonson, B. (CERN, Geneva); Alpsten, M.; Appelquist, A.; Astner, G. Nucl. Phys.; A177: No. 1, 81-102(1971).

Levels and transitions in ^{207}Po have been studied in the decay of ^{207}At, produced as daughter activity from mass separated ^{207}Rn samples. Information from γ- and conversion electron spectra and from coincidence experiments has been used to establish levels and—in most cases—deduce spin assignments. One-quasiparticle states have been identified as follows: g.s. ($2f_{\frac{9}{2}}$), 68 keV ($3p_{\frac{1}{2}}$), 236 keV ($3p_{\frac{3}{2}}$), 1115 keV ($1i_{\frac{13}{2}}$) and—tentatively—1676 keV ($2f_{\frac{5}{2}}$), The β-branches to levels at 2230 ($\frac{9}{2}^+$) and 2303 keV ($\frac{9}{2}^+$) have been found to proceed with log ft values around 6.5. They are interpreted as $\pi(h_{\frac{9}{2}}) \rightarrow \nu(g_{\frac{9}{2}})$ transitions. Together they contain about 25% of the $\pi(h_{\frac{9}{2}}) \rightarrow \nu(g_{\frac{9}{2}})$ strength observed in ^{209}Pb → ^{209}Bi. Other levels are fed with log ft >7. The results of this ^{207}Po investigation are compared with information on the lead isotone ^{205}Pb. The excitation energy of phonon states in these two nuclei shows a lowering of, on an average, 135 keV when going from ^{205}Pb to ^{207}Po compared to 160 keV in the neighboring doubly even isotopes. (auth)

14134 ISOBARIC ANALOGUE RESONANCES IN THE ^{103}Rh + p REACTIONS. Zioni, J.; Jaffe, A. A.; Drory, Ch.; Nir, D. (Hebrew Univ., Jerusalem). Nucl. Phys.; A173: No. 1, 92-6(1971).

Isobaric analog states were observed as resonances in the excitation function for the elastic scattering of protons from ^{103}Rh and for the (p,n) reaction on the same target. The results were compared with results of the (d,p) reaction on ^{103}Rh. Total and partial widths were calculated. The Coulomb displacement energy was found to be 12.860 ± 0.015 MeV. (auth)

14135 STRONG E0 TRANSITION IN ^{206}Pb FOLLOWING THE DECAY OF ^{206}Tl. Griffin, Henry C.; Donne, Alan M. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett.; 28: No. 2, 107-8(10 Jan 1972).

Pb K x rays and ~1.08-MeV K-conversion electrons were found among radiations emitted in the decay of 4.2-min ^{206}Tl. These radiations imply the existence of weak β transitions (0.08%) to the 1.17-MeV 0^+ state in ^{206}Pb, which decays primarily by an E0 transition to the ground state. (auth)

14136 α PICKUP IN THE A = 90 REGION. Detraz, C.; Zafiratos, C. D.; Rudolph, H.; Zaidins, C. S. (Univ. of Colorado, Boulder). Phys. Rev. Lett.; 28: No. 2, 117-20(10 Jan 1972).

The (^{3}He, ^{7}Be) reaction was observed for targets of ^{92}Zr and ^{93}Nb at 41 MeV. The reaction displays features expected from the pickup of an α-like fragment. The values of the cross sections agree with a prediction based on known proton spectroscopic factors. Contrary to current shell-model predictions, the trend of (^{3}He, ^{7}Be) cross sections does not require that the α spectroscopic factors change by more than 1 order of magnitude from ^{12}C to ^{93}Nb. (auth)

14137 DEUTERON ELASTIC SCATTERING FROM THE TIN ISOTOPES. Winsborrow, Lesley A. (King's Coll., London); Thomas, G. L.; Coleman, C. F.; Conlon, T. W. Nucl. Phys.; A180: No. 1, 19-36(1972).

Angular distributions are presented for the elastic scattering of 20 MeV deuterons from ^{112,118,124}Sn and of 27 MeV deuterons from ^{112,118,119,124}Sn. Satisfactory fits to the data were obtained using both the standard optical model and the reformulated optical model of Greenlees, Pyle and Tang. Comparison with potentials obtained from proton elastic scattering showed consistently smaller mean square radii for the 100 MeV deuteron potential. The use of shallow real well gave too large a mean square radius and difference functions of the data could not be reproduced with the shallow well. Values of the parameter γ, a measure of the rate of change of the rms radius with A, suggest an approximately $A_{\frac{1}{3}}$ variation. (auth)

14138 DETECTION OF PION SINGLE CHARGE EXCHANGE IN ZIRCONIUM. Alster, J. (Tel-Aviv Univ., Israel); Ashery, D.; Yavin, A. I.; (and others). Phys. Rev. Lett.; 28: No. 5, 313-15(31 Jan 1972).

The reaction ^{91}Zr(π^+,π^0)^{91}Nb* was observed by detecting the decay proton $\tilde{p}$ from the isobaric analog state ^{91}Nb* in the sequential process ^{91}Zr($\pi^+,\pi^0\tilde{p}$)^{90}Zr. The observed cross section for an incident pion energy of 30 MeV is 1.1 ± 0.8 mb, and is in reasonable agreement with theoretical calculations. (auth)

14139 DECAY OF A THREE-QUASIPARTICLE STATE IN ^{177}Ta. Huebel, H.; Naumann, R. A.; Spejewski, E. H. (Princeton Univ., N. J.). Phys. Rev., C; 4: No. 6, 2272-82(Dec 1971).

The decay of a three-quasiparticle isomeric state at 1355 keV in ^{177}Ta was studied using in-beam γ-ray spectroscopic techniques. Tantalum isotopes were produced by the ^{175,176}Lu(α,xn) reactions with α-particle energies between 24 and 48 MeV. The half-life of the isomer was measured to be $t_{\frac{1}{2}}$(1355 keV) = 5.02 ± 0.20 μsec, and its spin and parity were determined to be $I^\pi = 21/2^-$. The E2/M1 mixing ratios and the rotational-model parameters $(g_K - g_R)^2/Q_0^2$ were deduced for five ΔI = transitions between members of the rotational band based on the $9/2[514]$ state. (auth)

14140 FISSION-FRAGMENT ANGULAR MOMENTUM IN CHARGED-PARTICLE-INDUCED FISSION. I. ^{134}Cs AND ^{115}Cd ISOMER RATIOS. Loveland, W. D.; Shum, Y. S. (Oregon State Univ., Corvallis). Phys. Rev., C; 4: No. 6, 2282-8(Dec 1971).

The ^{134}Cs and ^{115}Cd isomer ratios have been measured for the following cases of charged-particle-induced fission: ^{238}U(35-MeV α,f), ^{232}Th(20-MeV d,f), ^{226}Ra(19-MeV d,f), and ^{209}Bi(35-MeV α,f). The values of the ^{134}Cs isomer ratio were 0.52 ± 0.02, 0.64 ± 0.01, and 0.20 ± 0.05 for the fission of ^{238}U, ^{232}Th, and ^{226}Ra, respectively. The ^{115}Cd isomer ratios were 0.090 ± 0.006, 0.059 ± 0.007, 0.90 ± 0.12, and 0.9 ± 0.2 for the fission of ^{238}U, ^{232}Th, ^{226}Ra, and ^{209}Bi, respectively. The low values of the ^{115}Cd isomer ratios for the fission of ^{238}U and ^{232}Th are attributed to decay-scheme effects. The average initial fragment angular momentum was deduced from the isomer-ratio values using the Vandenbosch–Huizenga formalism. The values obtained were (11 ± 1)ħ, (13 ± 1)ħ, and (7 ± 2)ħ for the ^{134}Cs fragment in the fission of ^{238}U, ^{232}Th, and ^{226}Ra, respectively. Values of >(15 ± 4)ħ and >(13 ± 4)ħ for the ^{115}Cd fragment in the fission of ^{226}Ra and ^{209}Bi were obtained. These results are discussed in terms of current theories about the origin of the fragment angular momentum in fission. (auth)

14141 STUDY OF THE ENERGY LEVELS OF ^{112}Cd USING NUCLEAR PHOTOEXCITATION. Moreh, R.; Nof, A. (Nuclear Research Center, Negev, Israel). Phys. Rev., C; 4: No. 6, 2265-71(Dec 1971).

Elastic and inelastic scattering of monochromatic photons were used for studying nuclear energy levels in ^{112}Cd; the photons were produced by thermal-neutron capture in iron. The energy of the resonance level was 7632 keV; it was found to decay to 19 known low-lying energy levels in ^{112}Cd. The angular distributions of the elastic and inelastic lines were measured and the following spin-parity determinations were made (energy in keV, J^π): 617, 2^+; 1223, 0^+; 1429, 0^+; 1468, 2^+; 1869, 0^+; 2832, 0^+; 2850, 2^+; 3110, 2; 3193, 2; 3247, 0; and 7632, 1^-. The parity of the last level was directly determined by polarization measurements, while the parities of the other levels were inferred from the radiation strength of the corresponding high-energy transitions. The M2/E1 mixing ratio for one primary transition was found to be about 3 orders of magnitude higher than that predicted by the simple theory. The results of a statistical analysis of the data are given. (auth)

14142 ELASTIC AND INELASTIC SCATTERING OF α PARTICLES AND PROTONS FROM ^{144}Sm. Barker, J. H.; Hiebert, J. C. (Texas A and M Univ., College Station). Phys. Rev., C; 4: No. 6, 2256-65(Dec 1971).

Differential cross sections for the elastic scattering and inelastic scattering to the low-lying states in ^{144}Sm have been measured using 50-MeV α-particle and 30-MeV proton beams from the Texas A&M variable-energy cyclotron. Spin and parity assignments are checked and transition strengths measured for states at 1.66, 1.81, and 2.19 MeV. A 2^+ assignment is made for a state at 2.45 ± 0.02 MeV. The angular distributions are analyzed in the distorted-wave Born approximation, employing collective-model form factors. The present results are compared with previous experimental data and with recent theoretical calculations of the states in ^{144}Sm. (auth)

14143 ABSOLUTE CROSS SECTIONS FOR 2-keV NEUTRON CAPTURE IN ^{204}Pb AND ^{207}Pb. Greenwood, R. C.; Reich, C. W. (Idaho Nuclear Corp., Idaho Falls). Phys. Rev., C; 4: No. 6, 2249-55(Dec 1971).

The prompt γ-ray spectrum resulting from capture of 2-keV neutrons in natural lead samples was measured using the 2-keV neutron beam facility of the Materials Testing Reactor. Primary capture γ-ray lines resulting from neutron capture in both ^{204}Pb and ^{207}Pb were observed in this spectrum. From these data, and utilizing the 477-keV prompt γ rays resulting from the ^{10}B(n,α)

reaction as a flux monitor, cross-section values of 1.8 ± 0.5 b and 3.2 ± 1.2 mb, respectively, were obtained for capture of these 2-keV neutrons in ^{204}Pb and ^{207}Pb. These data also provide additional information about the level scheme of ^{205}Pb, including the existence of a previously unreported level at 1748.4 keV, with spin of $\frac{1}{2}$ or $\frac{3}{2}$ and with probable negative parity. A value of 6731.7 ± 0.6 keV was obtained for the neutron binding energy of ^{205}Pb. (auth)

14144 LINEWIDTHS OF THE 46.5- AND 99.1-keV LEVELS OF ^{183}W. Boolchand, P. (Univ. of Cincinnati); Jha, S.; Robinson, Berol L. Phys. Rev., C; 4: No. 6, 2231-3(Dec 1971).

Using ^{183}Re sources in cubic matrices of tungsten metal and tantalum metal, lower limits to the half-lives of the $\frac{3}{2}^-$ 46.5-keV and $\frac{5}{2}^-$ 99.1-keV levels of ^{183}W are found to be 188 ± 4 psec and 975 ± 40 psec, respectively. (auth)

14145 INTERACTION OF 28-GeV PROTONS WITH URANIUM: CHARGE AND MASS DISTRIBUTION OF RARE-EARTH PRODUCTS. Chu, Y. Y.; Franz, E. M.; Friedlander, G.; Karol, P. J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 4: No. 6, 2202-18(Dec 1971).

Independent and cumulative yields of about 50 rare-earth nuclides produced in the interaction of 28-GeV protons with uranium have been measured. Chain yields on the neutron-excess side of β stability were found to have the same mass dependence as in low-energy fission. Based on the results obtained in the present study and with the aid of the published Cs isotopic distribution, charge-dispersion curves at A ≈ 147 and A ≈ 170 were constructed. The curve at A ≈ 147 has two maxima, one on the neutron-deficient and one on the neutron-excess side of β stability, separated by a deep valley; the curve at A ≈ 170 has a single peak on the neutron-deficient side of β stability. Corrections were made for feeding and depletion of various mass chains by α decay. Total isobaric yields were determined for 11 mass numbers between A = 143 and A = 171. On the basis of these results and published data at lower masses, a mass-yield curve was constructed. The apparent constancy of the neutron-deficient yields between mass 143 and mass 171 is consistent with the yield pattern of a spallation-like process. Over the mass range 50 < A < 160, binary fission and spallation cannot account for all the observed yields. Other processes must be partially responsible for the production of these nuclides, especially at the lower masses. (auth)

14146 SHAPE ISOMERS AND THE DOUBLE-HUMPED BARRIER. Clark, David D. (Cornell Univ., Ithaca, N. Y.). Phys. Today; 24: No. 12, 23-31(Dec 1971).

The discovery of shape isomers and their explanation by means of the double-humped barrier are reviewed. Evidence for the existence of isomers comes from four different lines of experimental and theoretical research: the existence of isomers that decay by spontaneous fission, calculations of the total nuclear binding energy that include shell effects, the energy dependence of the cross section for fission induced by neutrons or by the (d,p) reaction, and the interpretation of fission-fragment angular distributions. Attempts to achieve a quantitative theory of the phenomenon are discussed. (7 figures, 35 references). (R.W.R.)

14147 LEVEL STRUCTURE OF ^{178}Hf. Little, P. E. (Vanderbilt Univ., Nashville); Hamilton, J. H.; Ramayya, A. V.; Johnson, Noah R. Phys. Rev., C; 5: No. 1, 252-70(Jan 1972).

The level structure of ^{178}Hf was studied via γ singles, $\gamma-\gamma$ coincidences in the 2048 × 4096 channel mode, and $\gamma-\gamma$ directional-correlation measurements with Ge(Li) detectors from the decay of ^{178}Ta. These data yielded 7 new transitions and the addition of 13 transitions to the decay scheme, which includes 5 new levels. The following levels were observed (energies in keV followed by the spin and parity): 93.12, 2^+; 306.52, 4^+; 1174.64, 2^+; 1199.24, 0^+; 1276.54, 2^+; 1309.91, 1^+, 2^+; 1362.36, $2^{(-)}$; 1433.97, 0^+; 1443.86, 0^+; 1496.02, 2^+; 1513.64, 1^+, 2^+; 1561.27, 2^+; 1566.45, 1^+, 2^+; and 1771.95, 0^+. $\gamma-\gamma$ directional correlations were measured with the $2^+ \rightarrow 0^+$, 93.13-keV transition and eight transitions that feed the first excited state. From the $\gamma-\gamma(\theta)$ data, spins of 2 and 0 are established for the 1362.36- and 1771.95-keV levels and M1 admixtures of $85.6^{+\infty}_{-7}$% and 65.2 ± 3.2% for the 1183.40- and 1402.87-keV transitions. With these multipole admixtures, the branching ratios for the $K^\pi I = 0^+2$, 1276.54-keV level cannot be brought into agreement with theory for a single Z_β band-mixing parameter; for the $K^\pi I = 0^+2$, 1496.02-keV level, however, they can be. (auth)

14148 IDENTIFICATION OF ^{94}Kr AND ^{143}Xe, AND MEASUREMENT OF γ-RAY SPECTRA AND HALF-LIVES OF NUCLIDES IN THE MASS CHAINS 93, 94, AND 143. Amiel, S.; Feldstein, H.; Oron, M.; Yellin, E. (Soreq Nuclear Research Centre, Yavne, Israel). Phys. Rev., C; 5: No. 1, 270-3(Jan 1972).

Fission-produced nuclides ^{94}Kr and ^{143}Xe were measured directly using on-line mass separation. The half-lives derived from the β-decay curve are 0.20 ± 0.01 and 0.3 ± 0.03 s, respectively. γ-ray spectra in the mass chain 93 were measured, and various γ peaks were assigned to the individual nuclides. (auth)

14149 NUCLEAR EXCITATION BY POSITRON ANNIHILATION. Mukoyama, Takeshi; Shimizu, Sakae (Kyoto Univ.). Phys. Rev., C; 5: No. 1, 95-9(Jan 1972).

A new mode of positron annihilation was investigated experimentally. In this annihilation process without emission of radiation, the excess energy liberated is given to the nucleus involved. The experimental evidence for this process was established by observing the conversion electrons from ^{115m}In, first excited level (335 keV, $\frac{1}{2}^-$), after irradiation of natural indium foils by positrons from the β^+ decay of ^{22}Na. By using the experimental data obtained, an attempt was made to evaluate the cross section for positrons having just the energy corresponding to that necessary to excite ^{115}In from the ground state to an excited level which may decay to the isomeric level concerned. The experimental value of the cross section is found to be $\sim 10^{-24}$ cm^2, while the theoretical value estimated by Present and Chen is $\sim 10^{-26}$ cm^2. Possible reasons for this difference are discussed. (auth)

14150 CHARGE DISTRIBUTION IN THE FISSION OF ^{232}Th. Rao, S. A. (Univ. of Arkansas, Fayetteville). Phys. Rev., C; 5: No. 1, 171-7(Jan 1972).

Independent-fission yields of $^{95m+g}$Nb, ^{96}Nb, ^{99m}Tc, ^{106}Rh, ^{112}Ag, ^{115m}In, ^{134m}Cs, and ^{135m}Cs and fission yields of four mass chains in the symmetric region A = 111 to 115 were determined in the fission of ^{232}Th induced by 14.8-MeV neutrons. Various postulates of charge distribution were tested to correlate the experimental data. It was found that the equal-charge-displacement hypothesis agreed well for the fission products produced by the asymmetric mode of fission, and the constant-charge-ratio postulate showed the best correlation for the fission products produced by the symmetric mode of fission. Evidence for 40- and 50-proton shell effects on the fission yields was found. (auth)

14151 THERMAL-NEUTRON-CAPTURE γ RAYS FROM THE REACTION ^{207}Pb(n,γ)^{208}Pb. Mariscotti, M. A. J. (Brookhaven National Lab., Upton, N. Y.); Gelletly, W.; Kane, W. R. Phys. Rev., C; 5: No. 1, 178-82(Jan 1972).

The thermal-neutron-capture γ-ray spectra from natural Pb and enriched ^{207}Pb were studied with a 20-cm^3 Ge(Li) detector. A careful comparison of these spectra reveals the existence of two weak γ-ray cascades (intensity $\approx 10^{-3}$ times the intensity of the primary transition to the ^{208}Pb ground state) from the neutron-capture state to the ^{208}Pb ground state. These cascades have energies 4753.7−2614.0 keV and 3283.3−4086.0 keV and pass through the first excited 3^- state at 2614.0 keV and a 2^+ state at 4086.0 keV, respectively. The neutron separation energy of ^{208}Pb was measured to be 7367.7 ± 0.7 keV. (auth)

14152 LOW-LYING STATES IN ^{122}Sb FROM THE ^{122}Sn(p,n) REACTION. Elliott, D. O.; Phillips, G. W.; Hopkins, F. F.; Richard, Patrick (Univ. of Texas, Austin). Phys. Rev., C; 5: No. 1, 202-9(Jan 1972).

The low-lying level structure of ^{122}Sb was studied through the observation of coincident γ rays following the ^{122}Sn(p,n) reaction by using two Ge(Li) detectors. Thirteen 1024-channel coincidence γ-ray spectra were obtained simultaneously in a PDP-7 computer by means of a two-parameter program. High-resolution singles spectra taken with a small-volume thin-window Ge(Li) detector (full width at half maximum approximately 0.6 keV at 121 keV) were also helpful in determining a level scheme for ^{122}Sb. A (d,p) experiment was also performed in order to gain additional information. The information obtained from the (p,n) reaction was combined with existing ^{121}Sb(d,p) and ^{121}Sb(n,γ) data in constructing a proposed level scheme for ^{122}Sb. (auth)

14153 FISSION OF ^{238}U BY 2.2-GeV PROTONS. II. Baechmann, K.; Cumming, J. B. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 5: No. 1, 210-19(Jan 1972).

Differential range curves (at an angle of 90°) were obtained by radiochemical methods for 17 isotopes of Cu, Sr, Pd, and Ba which recoil out of thin uranium targets irradiated with 2.2-GeV protons. Neutron-rich isotopes of Ba, Pd, and Sr all have sharply peaked spectra with mean momenta >120 (MeV amu)$_k$, consistent with their production by binary fission. Neutron-deficient isotopes of these elements are characterized by lower mean momenta [<106 (MeV amu)$_k$] and broader spectra which include significant low-momentum components [<50 (MeV amu)$_k$]. The absolute contribution of these low-momentum recoils decreases from the order of a few mb/amu at mass 128 or 131 to ≈0.1 mb/amu at mass 83. Fission and some contribution from a spallationlike process are suggested as the probable formation mechanisms for the neutron-deficient products. The formation mechanism for copper isotopes

is not clear. Spectra of ^{61}Cu, ^{64}Cu, and ^{67}Cu have widths comparable to those observed for binary fission and contain few low-momentum recoils; however, mean momenta are lower than those observed in semiconductor measurements of fission or predicted by a liquid-drop theory. (auth)

14154 Rb AND Cs ISOTOPIC CROSS SECTIONS FROM 40- TO 60-MeV-PROTON FISSION OF ^{238}U, ^{232}Th, AND ^{235}U. Tracy, B. L.; Chaumont, J.; Klapisch, R.; (and others) (Centre National de la Recherche Scientifique, Orsay, France). Phys. Rev., C: 5: No. 1, 222-34(Jan 1972).

The isotopic distributions of Rb and Cs from the fission of ^{232}Th, ^{235}U, and ^{238}U, induced by 40- to 60-MeV protons were measured by means of an on-line mass spectrometer. The Rb isotopic distributions have a Gaussian shape, but those of Cs are somewhat asymmetrical. As the proton bombarding energy increases, the neutron-excess sides of the distributions remain approximately fixed while the neutron-deficient sides shift to lower mass numbers. The distributions also show significant variations with the neutron-to-proton ratio of the target. All the isotopic cross sections show a significant odd–even structure, with the formation of even neutron isotopes being favored. The effect is more pronounced for the neutron-rich isotopes. A similar structure is found to occur in Rb and Cs distributions from fission induced by thermal neutrons, 155-MeV protons, and 24-GeV protons, as well as in the Na and K cross sections from 24-GeV-proton reactions with a variety of targets. The odd–even effect in the Rb and Cs distributions can be accounted for by a 10 to 15% neutron-pairing effect in the prompt yields and a 2 to 3% pairing effect in the neutron emission. From the mean mass numbers of the Rb and Cs distributions, the average total number of emitted neutrons was estimated for each reaction. This information, together with other results on neutron emission as a function of fragment mass, allowed the mean mass numbers to be corrected for prompt neutron emission. These corrected values differ by about one mass unit from the values predicted by the unchanged-charge-density mechanism and are consistent with the same mechanism of charge division as that operating in thermal-neutron fission. (auth)

14155 NEUTRON RADIUS OF ^{208}Pb FROM 166-MeV ALPHA-PARTICLE SCATTERING. Tatischeff, B.; Brissaud, I.; Bimbot, L. (Institut de Physique Nucleaire, Orsay, France). Phys. Rev., C; 5: No. 1, 234-7(Jan 1972).

The elastic scattering of α particles is analyzed with an optical potential obtained by a simple folding of the nuclear-matter distribution with α–nucleon interaction. The ^{208}Pb neutron-matter radius is extracted using the charge-distribution parameters. The result, $\gamma_{nm} = 5.75 \pm 0.09$ fm, is compared with other determinations and some theoretical calculations. (auth)

14156 THREE FRAGMENT FISSION. Halpern, I. (Univ. of Washington, Seattle). Annu. Rev. Nucl. Sci.; 21: 245-94 (1971).

The abundant experimental material available on ternary fission is examined for what it can explain about the initial conditions at the "instant" of scission. What has been learned from comparisons of the distributions occurring in ternary fission with the corresponding distributions in binary fission is first reviewed. The problem of the relative probabilities for the emission of different species of third particles (Z = 0, 1, 2, 3 and 4, 5 to 8, and >8) is discussed. The dependence of third-particle emission on various experimental variables (target species, excitation energy, angular momentum) is considered. The observed third-particle energy spectra and angular distributions are described. Finally, the correlations between the various observables in ternary fission are treated. (16 figures, 1 table, 90 references). (R.W.R.)

14157 NUCLEAR γ RAYS FOLLOWING K^- CAPTURE. Bloom, S. D. (Univ. of California, Livermore); Weiss, M. S.; Shakin, C. M. Phys. Rev., C; 5: No. 1, 238-41(Jan 1972).

It is suggested that the study of the nuclear deexcitation γ rays emitted following K^- capture may help clarify the nature of the capture mechanism. Capture in ^{208}Pb and ^{16}O is considered. Capture rates to the various proton or neutron single-hole states in ^{207}Pb, ^{207}Tl, ^{15}O, and ^{15}N are estimated, and the consequences of capture to the isomeric states in ^{207}Pb and ^{207}Tl are discussed. (auth)

14158 INDEPENDENT YIELD OF ^{112}Ag FROM THERMAL NEUTRON INDUCED FISSION OF ^{233}U AND ^{235}U. Roche, M. F. (Univ. of Missouri, Columbia); Troutner, D. E.; Ferguson, Robert L. Radiochim. Acta; 16: No. 2, 66-71(Nov 1971).

The independent yield of ^{112}Ag was measured for thermal neutron induced fission of ^{233}U and ^{235}U by using timed precipitations of palladium dimethylglyoxime to separate the palladium and silver fission products. The values obtained for the fractional independent yields are $(3.0^{+0.5}_{-1.5}) \cdot 10^{-4}$ and $<1 \cdot 10^{-4}$, respectively. These results are consistent with a charge distribution for near-symmetric mass 112 in which either or both the most probable charge and the width of the distribution are somewhat smaller than values estimated from knowledge of charge distribution in the mass peaks. (auth)

14159 INDEPENDENT YIELDS OF ^{133}I, ^{134}I, AND ^{135}I IN THE FISSION OF ^{232}Th INDUCED BY REACTOR NEUTRONS AND 14.8 MeV NEUTRONS: CHARGE DISTRIBUTION IN LOW AND MEDIUM ENERGY FISSION. Denschlag, H. O.; Qaim, S. M. (Univ., Mainz). J. Inorg. Nucl. Chem.; 33: No. 11, 3649-61 (Nov 1971).

The fractional independent yields of ^{133}I, ^{134}I and ^{135}I were measured to be ≤ 0.05, ≤ 0.03 and 0.15 ± 0.03, respectively for the epi-cadmium reactor neutron induced fission of ^{232}Th and 0.08 ± 0.02, 0.152 ± 0.005 and 0.47 ± 0.08, respectively for the 14.8 MeV neutron induced fission of ^{232}Th. An upper limit of 0.02 for the fractional independent yield of ^{135}Xe was also established. From the experimental results the width parameter (σ) of the Gaussian charge dispersion curve in the 14.8 MeV neutron induced fission was found to be ≤ 0.56. The results are discussed in terms of the effect of increasing incident neutron energy on charge distribution. (auth)

14160 STUDY OF THE ^{141}Pr(p,xn) REACTION FROM 10 TO 85 MeV. Hogan, James J. (McGill Univ., Montreal). J. Inorg. Nucl. Chem.; 33: No. 11, 3627-41(Nov 1971).

Excitation functions for the production of the ^{141}Pr(p,xn)$^{142-x}$Nd nuclear reactions for proton bombarding energies ranging from 10 to 85 MeV were measured. These experimental results were compared to excitation functions calculated by the two models of the most widely used intranuclear cascade calculation. Strengths and deficiencies of both models are discussed, with particular reference to their sensitivity to capture of the impinging proton. Special emphasis is given to calculation of the production of the two isomers of ^{139}Nd. (auth)

14161 COMPARISON OF NUCLEAR CHARGE DISTRIBUTION IN THERMAL-NEUTRON INDUCED FISSION OF ^{233}U AND ^{235}U. Troutner, D. E. (Univ. of Missouri, Columbia). J. Inorg. Nucl. Chem.; 33: No. 12, 4327-33(Dec 1971).

Fractional cumulative yields of heavy products from the fission of ^{235}U and ^{233}U and also the fractional cumulative yields of light products from the fission of ^{235}U and ^{233}U shown as yields of complements are each tabulated. From a knowledge of values of fractional independent and cumulative yields an understanding of the nuclear charge distribution which occurs during the fission process is possible. The relationship between yields from the two processes is deduced and discussed. (UK)

14162 MASS DISTRIBUTION OF 3 MeV NEUTRON INDUCED FISSION OF ^{232}Th. Swindle, D. L.; Moore, D. T.; Beck, J. N.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem.; 33: No. 11, 3643-7(Nov 1971).

The 3-MeV neutron-induced fission yields of ^{232}Th in the mass regions of A = 77 to 93 and A = 141 to 156 were radiochemically determined by isolating fission products belonging to 15 mass chains. The absolute activities for the nuclides were determined by β- and γ-counting and the cumulative fission yields were calculated relative to ^{99}Mo. These data were used to define the extreme wings of the mass yield curve for ^{232}Th. By comparison of complementary fission fragments it was determined that 2.4 secondary neutrons are emitted per fission of ^{232}Th at 3 MeV. A qualitative comparison is made concerning the general features of the ^{232}Th mass yield curves from 14.8 MeV and 3 MeV neutron induced fission. (auth)

14163 PRECISION DETERMINATION OF THE HALF-LIFE OF ^{186}Re AND ^{188}Re. Michel, R.; Herpers, U. (Univ., Cologne). Radiochim. Acta; 16: No. 2, 115(Nov 1971). (In German).

The half-lives of ^{186}Re and ^{188}Re were found to be 90.64 ± 0.09 hours and 16.98 ± 0.02 hours, respectively. (L.T.W.)

14164 DEVIATION OF THE γ RAY ENERGY DISTRIBUTIONS FROM THE STATISTICALLY EXPECTED DISTRIBUTIONS. Sumbaev, O. I.; Smirnov, A. I.; Kondurova, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1276-83(Oct 1971). (In Russian).

It is demonstrated that, for ^{46}Sc, ^{60}Co, ^{76}As, ^{94}Nb, ^{104}Rh, ^{116}In, ^{140}La, ^{142}Pr, and ^{198}Au nuclei, the probability that the energies of soft ($50 \lesssim E \lesssim 600$ keV) intense γ lines of complex (n,γ) spectra of odd–odd spherical nuclei, measured with precise diffraction spectrometers, equal A/m, 2A/m, ..., 5A/m, where $\bar{A}_{exp} = 1021.2 \pm 2.2$ keV and m is an integer, is high compared with the Poisson or Wigner–Dyson random numbers. According to the most rigid of the criteria used, the randomness probability is $2.7 \cdot 10^{-5}$, which corresponds to the 3σ criterion usually accepted as the confidence

level. Attempts to explain the closeness between A and $2m_ec^2$ as being the result of processes involving atomic electrons affecting the γ line intensity indicate that the respective cross sections are insufficient. (auth)

14165 SUB-BARRIER PHOTO-FISSION OF EVEN-EVEN NUCLEI. Ignatyuk, A. V.; Rabotnov, N. S.; Smirenkin, G. N.; Soldatov, A. S.; Tsipenyuk, Yu. M. (Physical Problem Inst., Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 4, 1284-1302(Oct 1971). (In Russian).

The angular distributions of the fragments and the photofission cross sections for ^{238}U and ^{232}Th were measured by using the bremsstrahlung beam from the microtron of the Institute for Physical Problems. Metallic uranium and thorium foils were employed as the fissioning targets. Scattering of fragments by nuclei of the fissioning material was taken into account in treatment of the results. Nonregularities in the sub-barrier energy region were observed which apparently correspond to quasi-stationary states of the vibrational type in the second well. The results of the present experiment and of previous measurements are analyzed within the framework of the two-hump barrier model with a potential consisting of three conjugate parabolas. It is shown that a description of resonance structures requires that allowance be made of damping of vibrational motion, which is included by adding an imaginary part to the potential. (auth)

14166 STRUCTURE OF THE LIGHTER N = 82 NUCLEI. Wildenthal, B. H.; Larson, Duane (Michigan State Univ., East Lansing). Phys. Lett.; 37B: No. 3, 266-8(29 Nov 1971).

Shell-model predictions for nuclei which can be characterized as 1, 2 and 3 protons outside the doubly-magic N = 82, Z = 50 core give a good accounting for recently discovered features of ^{133}Sb, ^{134}Te and ^{135}I. (auth)

14167 EFFECTIVE INTERACTION BETWEEN THE $J^\pi = 2^+$ TWO-PHONONS STATES IN ^{208}Pb. EVIDENCE FOR THE EXISTENCE OF THE ISOVECTOR QUADRUPOLE MODE. Broglia, R. A. (Univ. of Copenhagen. State Univ. of New York, Stony Brook); Paar, V.; Bes, D. R. Phys. Lett.; 37B: No. 3, 257-62 (29 Nov 1971).

The effective interaction between the states of two-phonons with $J^\pi = 2^+$ in ^{208}Pb is constructed. Special attention is paid to the states $|2_1^+(^{206}\text{Pb}) \otimes gs(^{210}\text{Pb});2\rangle$ and $|gs(^{206}\text{Pb}) \otimes 2_1^+(^{210}\text{Pb});2\rangle$ and the predictions are compared with the ^{210}Pb(p,t) and ^{206}Pb(t,p) data. The results obtained using the usual particle-vibration interaction vertices overpredicts the splitting between the two $J^\pi = 2^+$ states by a factor of 5. This discrepancy is removed when the effect of the isovector quadrupole mode is taken into account. This result provides for the first time a clear evidence on the existence of such a mode which dramatically renormalizes (screens) the quadrupole interaction between particle and holes. It also provides for the first time with a clear case of quadrupole pairing phonons conserving their identity when used as building blocks of the nuclear spectrum even after the different anharmonicities are taken into account. (auth)

14168 HALF-LIFE OF ^{208}Tl(ThC''). Ackerhalt, R.; Ellerbe, P.; Harbottle, G. (Brookhaven National Lab., Upton, N. Y.). Radiochem. Radioanal. Lett.; 8: No. 2, 75-7(14 Oct 1971).

The half-life of ^{208}Tl has been measured to a high precision, in excellent agreement with an earlier precise measurement in the literature. The new value is 3.0527 ± 0.0033 minutes. (auth)

14169 EMISSION OF PROMPT FISSION NEUTRONS. Kluge, Gy. (Central Research Inst. for Physics, Budapest). Phys. Lett.; 37B: No. 3, 217-20(29 Nov 1971).

Different approaches, including a detailed cascade calculation of the center of mass spectra of fission neutrons emitted from the individual fragments of the spontaneous fission of ^{252}Cf, are compared in the determination of the total energy and angular distributions of fission neutrons (TEAD). The existence of "scission" neutrons is questioned and the corrections arising from the form of the approach are discussed. (auth)

14170 RESONANCE PARAMETERS OF FISSIONABLE NUCLEI. Sukhoruchkin, S. I. At. Energ. (USSR); 31: No. 6, 595-609(Dec 1971). (In Russian).

Experimental information on the resonance parameters of heavy fissionable nuclei is reviewed. Progress in determining such average characteristics of these nuclei as strength functions and partial widths is pointed out. The results obtained in the single-level approximation for analyzing the fission cross section are critically described. (10 figures, 7 tables, 108 references) (auth)

14171 NUCLEAR MATRIX ELEMENTS IN THE 806-keV BETA TRANSITION OF ^{147}Nd. Yamada, Shigeru; Hayashi, Takeo. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 73-6(1971).

Angular correlations in the 806-keV β-91-keV γ cascade in the beta decay of ^{147}Nd were measured with scintillation counters. Nuclear matrix parameters and matrix elements derived therefrom are tabulated. The deviation of this cascade from the ξ approximation is discussed. (1 figure, 3 tables) (R.W.R.)

14172 PARTICULARITIES OF THE STANDARDIZATION OF THE ELECTRON-CAPTURING RADIONUCLIDES. Plch, J.; Zderadicka, J.; Bucina, I. (Inst. for Research, Production, and Use of Radioisotopes, Prague). Radioisotopy; 11: No. 6, 975-95(1970). (In Czech).

The particularities of the standardization of the electron-capturing radionuclides are discussed, especially with regard to the coincidence method. In this case the accuracy of the activity determination is limited by the high uncertainty in the decay scheme correction. The results of the correction calculation are compared with the possibility of its experimental verification. The standardization of ^{133}Ba is given as an example of the problem. The conventional arrangement of the 4π X-γ coincidence equipment is not possible for some special decay schemes, and it is necessary to search for a special method or a special experimental device. The standardization of ^{109}Cd and ^{197}Hg is given as an example of these cases. (auth)

14173 MEASUREMENTS OF THE AVERAGED NEUTRON CROSS SECTION OF SOME THRESHOLD REACTIONS FOR FISSION NEUTRONS. Kanda, Keiji; Chatani, Hiroshi; Shibata, Toshikazu. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 94-8 (1971).

The averaged cross sections for some threshold reactions for fission neutrons were measured with a neutron energy converter consisting of 90% enriched uranium at the thermal neutron field of the KUR heavy-water facility. The induced gamma activities were measured with NaI(Tl) scintillation counters and a Ge(Li) counter calibrated with the IAEA standard gamma-ray sources. As the standard cross section, the value of 0.61 mb for the reaction ^{27}Al(n,α)^{24}Na was used. The obtained values of cross section are as follows: ^{24}Mg(n,p)^{24}Na, 1.28 ± 0.04 mb; ^{58}Ni(n,p)^{58}Co, 112 ± 3 mb; ^{115}In(n,n')^{115m}In, 171 ± 5 mb; ^{103}Rh(n,n')^{103m}Rh, 566 ± 23 mb; ^{204}Pb(n,n')^{204m}Pb, 8.80 ± 0.44 mb; and ^{204}Pb(n,2n)^{203}Pb, 1.16 ± 0.16 mb. These values agree with the previous experimental ones except for lead. (auth)

14174 MAGNETIC MOMENTS OF TWO EXCITED STATES IN ^{182}W. Seo, Takeshi; Hayashi, Takeo. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 77-9(1971).

The magnetic moments of the first 2^+ excited state and the 1289-keV 2^- state of ^{182}W were measured by the method of perturbed γ-γ angular correlations in an external magnetic field. Radioactive ^{182}Ta sources were used. A g factor of 0.193 ± 0.049 was obtained for the 2^+ state by using the 1121-100 keV cascade; the E2 content of the transition and the attenuation factor G_4 were determined to be 99 to 100% ($\delta < 0$) and 0.969 ± 0.031, respectively. For measurements on the 2^- state the 264-1189 cascade was used; an M2 content of 30% ($\delta > 0$) was found. This work yielded a lifetime of 1.37 ± 0.36 ns, a g factor of 1.16 ± 0.36, and a magnetic moment of 2.3 ± 0.7 n.m. (2 figures) (R.W.R.)

14175 LOW-SPIN STATES IN ^{110}Cd. Kawase, Yoichi; Okano, Kotoyuki; Uehara, Shinichi; Hayashi, Takeo. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 80-3(1971).

Singles and coincidence spectra from the decay of ^{110}Ag were measured by using Ge(Li) and NaI(Tl) detectors. Angular correlation measurements were made on the 816-658 cascade to ascertain the spin value of the initial state. The resulting decay scheme for ^{110}Cd is given. (4 figures) (R.W.R.)

14176 REDUCTION OF SYSTEMATIC ERRORS DURING THE MEASUREMENT OF $\sigma_c^{238}/\sigma_f^{235}$. Yurova, L. N.; Bushuev, A. V.; Bortsov, V. G.; Duvanov, V. M.; Kozhin, A. F. At. Energ. (USSR); 31: No. 6, 628-9(Dec 1971). (In Russian).

The ratio of the capture cross section of ^{238}U to the fission cross section of ^{235}U may be measured by using samples of depleted and enriched uranium, respectively, in a beam of thermal neutrons. Methods of increasing the accuracy of these measurements are discussed, with the result that the improved technique, in conjunction with a scintillation detector, is suitable for measurements in fuel systems with natural or slightly enriched uranium. (K.S.W.)

14177 STUDY OF LOW-LYING STATES IN ^{96}Nb BY THE ^{96}Zr(p,ny)^{96}Nb REACTION. Cochavi, S. (Brookhaven National Lab., Upton, N. Y.); Fossan, D. B. Phys. Rev., C; 5: No. 1, 164-71(Jan 1972).

Low-lying states of ^{96}Nb were studied via the ^{96}Zr(p,ny)^{96}Nb reaction. Ge(Li) γ spectra were measured in coincidence with neutrons at proton bombarding energies of 3.5 and 4.5 MeV. Five

γ rays were observed in these spectra and had energies to ±1 keV of 99, 181, 307, 326, and 450 keV. Two additional γ rays with energies of 38 and 43 keV were observed with a Si(Li) detector at E_p = 3.5 MeV. $\gamma-\gamma$ coincidence measurements were made with two Ge(Li) detectors to identify the ^{96}Nb decay scheme. These measurements suggest that the 38-, 43-, 99-, 181-, 326-, and 450-keV γ rays correspond to transitions between the 180 → 142-, 43 → 0-, 142 → 43-, 687 → 506-, 506 → 180-, and 630 → 180-keV levels in ^{96}Nb, respectively, $\gamma-$neutron and $\gamma-\gamma$ timing measurement yielded the following upper limits for mean lifetimes: τ(142-keV level) < 1.1 ns, τ(180) < 1.1 ns, τ(506) < 0.6 ns, τ(630) < 2 ns, and τ(687) < 2 ns. On the basis of the observed γ transitions and their strengths, spin assignments are made to the previously identified $(\pi g_{9/2})(\nu d_{5/2})^{-1}$ multiplet in ^{96}Nb. The 0-, 43-, 142-, 180-, and 630-keV states are assigned J^π values of 6^+, 5^+, 4^+, 3^+, and 2^+, respectively, which leaves the 233-keV state as the 7^+ member; these assignments are based on an assumed $(\pi g_{9/2})(\nu d_{5/2})^{-1}$ structure. These J^π values are in accord with the tentative spin assignments made in the $(^3He,t)$ study by Comfort et al. These results also agree with those predicted by the Pandya transformation from the known $(\pi g_{9/2})(\nu d_{5/2})$ multiplet in ^{92}Nb. (auth)

14178 NUCLEAR STRUCTURE OF THE N = 82 ISOTONES ^{140}Ce AND ^{139}La FROM THE (α,α') REACTION. Baker, F. Todd; Tickle, Robert (Univ. of Michigan, Ann Arbor). Phys. Rev., C; 5: No. 1, 182-201(Jan 1972).

Differential cross sections for elastic and inelastic scattering of 45-MeV α particles by the N = 82 isotones ^{140}Ce and ^{139}La were measured. Both collective- and microscopic-model distorted-wave Born-approximation analyses were performed to ascertain the collective nature of the levels excited; the wave functions used in the microscopic-model calculations were the eigenfunctions of the pseudo L−S coupling scheme recently developed by Hecht and Adler. The results of the collective-model analysis of the ^{140}Ce(α,α') data indicate that none of the levels excited are well described as mass vibrations. The microscopic-model calculations indicate that significant contributions from the core are needed in order to fit the magnitudes of the cross sections for transitions to the first 2^+ (1.597 MeV) and 4^+ (2.084 MeV) states of ^{140}Ce. The collective-model analysis of the ^{139}La(α,α') data permits parity assignments to be made for all levels excited; unfortunately, it is not possible to understand the features of the (α,α') spectrum in terms of a weak-coupling model. The microscopic-model calculations for the ^{139}La(α,α') experiment indicate that transitions which require a "psuedospin flip" are strongly inhibited. The features of the experimental ^{139}La(α,α') spectrum are consistent with this prediction. The $\Delta B = 0$ selection rule suggested by Hecht and Adler (B is the total pseudospin) is approximately obeyed for both reactions. (auth)

14179 RELATIVE QUADRUPOLE MOMENTS OF THE FIRST EXCITED STATES OF ^{180}W AND ^{182}W. Hershkowitz, N.; Wender, S. A.; Carpenter, A. B. (Univ. of Iowa, Iowa City). Phys. Rev., C; 5: No. 1, 219-21(Jan 1972).

The relative quadrupole moments of the first excited states of ^{180}W and ^{182}W are found to be $Q_{22}^{180}:Q_{22}^{182} = 1.031 \pm 0.043$ from Moessbauer-effect measurements following Coulomb excitation. (auth)

14180 NUCLEAR INVESTIGATIONS BY DOUBLE CHARGE EXCHANGE OF PIONS. Becker, F.; Batusov, Yu. A. (CRN, Strasbourg). Riv. Nuovo Cim.; 1: No. 3, 309-64(Jul-Sep 1971).

Double-charge-exchange reactions (DBCX) allow a number of aspects of nuclear structure to be studied. The analysis of final-state structure, mainly in systems with large neutron or proton excess or isobaric analog states corresponding to $\Delta t_3 = \pm 2$ of known nuclei, is first discussed. The analysis of the properties of the target itself is then considered. Different possible mechanisms are discussed, along with the properties of the transitions induced by DBCX and some possible analysis of the target nucleus that can be undertaken by the DBCX process. Finally, double charge exchange with π^- and π^+ incident mesons is compared to investigate neutron and proton distributions. (27 figures, 8 tables, 73 references) (R.W.R.)

Nuclear Theory

Refer also to abstracts 12130, 13188, 13721, 13724, 13782, 13824, 13844–13846, 13861, 13936, 13947, 14093, and 14146.

14181 (AECD/EP-21) CALCULATION OF TOTAL NEUTRON CROSS-SECTION BY OPTICAL MODEL. Ullah, M. Enayet; Hussain, Muhtasham (Atomic Energy Centre, Dacca (Pakistan)). Jan 1971. 7p. Dep. NTIS (U. S. Sales Only).

Optical model calculations of δ total for 15 mean radii following Emmerich are reported. The type of optical model used is a diffused potential with surface absorption. For each radius these cross sections are presented for 17 different energies ranging from 0.10 MeV to 14.0 MeV. (auth)

14182 (BARC-553) PROGRESS REPORT ON NUCLEAR DATA ACTIVITIES IN INDIA. VII. Balakrishnan, M. (comp.) (Bhabha Atomic Research Centre, Bombay (India)). 1971. 44p. Dep. NTIS (U. S. Sales Only).

A summary of theoretical and experimental research on nuclear physics at various institutions in India is presented. (J.F.P.)

14183 (BNL-tr-457) MODIFIED MODEL OF COMPLEX ANGULAR MOMENTA AND ITS APPLICATION TO RESONANT NUCLEAR REACTIONS. Grushin, V. V.; Nikitin, Yu. P. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz.; 13: No. 1, 156-63(1971). 15p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA25: 23102. (R.W.R.)

14184 (HMI-B-114) THEORY OF NUCLEAR MODELS. II. Eichler, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Oct 1971. 135p. (In German). Dep. NTIS (U. S. Sales Only).

This volume contains Part II of a course on nuclear models given at the Free University of Berlin in 1966. The collective model and the Nilsson model are discussed. (R.W.R.)

14185 (IJS-R-600) GENERATOR COORDINATE APPROACH FOR THE DESCRIPTION OF PAIRING VIBRATIONS IN THE SENIORITY ZERO SPACE. Justin, D.; Mihailovic, M. V.; Rosina, M. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Jun 1971. 17p. Dep. NTIS (U. S. Sales Only).

The application of the generator-coordinate method is extended to non-harmonic systems. The many dimensional Hill−Wheeler integral equation is reduced to a one-dimensional integral equation by expressing all independent parameters in the generator function by a single parameter. It is shown that the subspace spanned by a proper single-parameter family is the same as that spanned by the many-parameter family of generator functions. The subspace of the seniority-zero states relevant to the description of pairing vibrational states is spanned by the N-projected BCS function depending on the gap parameter. It is shown on a schematic three-level system that a good description of energies and two-body transfer amplitudes of the pairing vibrational states can be obtained in a subspace much smaller than the seniority-zero subspace. Since the method works equally well for superconducting nuclei, nonsuperconducting nuclei, and in the intermediate region, the suitability of the seniority-zero subspace for the description of low-lying O^+ states in Pb and Sn isotopes was tested. Only a qualitative description is possible. (auth)

14186 (JAERI-M-4380) CALCULATION OF PENETRATION FACTOR FOR A SQUARE POTENTIAL BARRIER. Tasaka, Kanji; Seki, Yasushi (Japan Atomic Energy Research Inst., Tokyo). Mar 1971. 28p. (In Japanese).

A computational code "TUNNEL," which calculates the penetration factor for a square potential (tunnel effect) is developed. Various characteristics of tunnel effect are investigated using the code "TUNNEL." As a result, it is concluded that the penetration factor for a square potential is given only by two parameters E/U and MUb^2. Here E and M are energy and mass of the incident particle to the potential; and U and b are energy and width of the square potential respectively. This article is a preliminary study in an attempt to give a phenomenological explanation for the energy dependence of mass chain yield of fission using the characteristics of the penetration factor for a square potential. The energy dependence of mass chain yield of fission is thoroughly described in another paper. Here the discussion is limited to the characteristics of the penetration factor for a square potential. (auth) (Japan)

14187 (JINR-E4-6138) KINEMATICS OF MUON CAPTURE. Ciechanowicz, S.; Oziewicz, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 45p. Dep. NTIS (U. S. Sales Only).

The tables of the formulas for the capture rates, gamma-neutrino correlations and angular distributions of the recoils in muon capture processes $J_i \xrightarrow{\mu} J_f$ for $J_i \leq 3$, $J_f \leq 5/2$ with and without change of the parity of nuclear levels are presented. These formulas are given explicitly in terms of the multipole amplitudes. The relations for the helicity mu-mesic atom decay amplitudes, multipole amplitudes, "neutrino waves" amplitudes and notations introduced by other authors are given. The formulas are convenient for model calculations of partial transitions with realistic

wave functions of nuclei and the muon, as well as for the phenomenological analysis. The derivation is based on kinematics only and the formulas are strictly valid for muon capture by any nuclei. (auth)

14188 (JINR–P4-6039) COUPLED CHANNEL ANALYSIS OF 12-MeV PROTON SCATTERING ON ^{148,154}Sm. Kurepin, A. B.; Schulz, H.; Wiebicke, H. J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

By means of the coupled channel program KASTOR which contains a least square fitting procedure the elastic and inelastic scattering on ^{148,154}Sm is analyzed. The effect of a Fermi charge distribution for the target nucleus is investigated. The optical and deformation parameters obtained are in good agreement with those given in other works. (auth)

14189 (JINR–P4-6098) ON A STATISTICAL MODEL OF A FINITE NUCLEUS. Babikov, V. V.; Khankhasaev, M. Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The investigation of the connection between the surface energy of a nucleus and selfconsistency condition for nuclear density and potential is made in the framework of an exactly solvable statistical model of a finite nucleus presented previously. The generalization of this model is obtained which leads to stability of the spherical nuclear shape with respect to small deformations of the nuclear surface. (auth)

14190 (JINR–P4-6102) PARTIAL TRANSITIONS IN THE MUON CAPTURE BY THE NUCLEUS ^{19}F. Hock, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

Within the framework of the shell model with intermediate coupling there were calculated the probabilities of allowed transitions in the reaction $\mu^- + {}^{19}F \rightarrow {}^{19}O^* + \nu$. (auth)

14191 (JINR–P4-6113) ON REALIZATIONS OF THE PHYSICAL BASIS OF SU(3) AND THE B(E2) TRANSITION PROBABILITIES IN THE SU(3) SCHEME. Avramov, S.; Afanas'ev, G. N.; Raichev, P. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

A new hermitean operator is introduced, the eigenvalues of which allow the basis vectors of the irreducible representation SU(3) to be specified completely. It is shown that indefiniteness in choice of the orthonormalized basis can be exploited for the correct description of the B(E2) transition probabilities. (auth)

14192 (JPRS–54305) BULLETIN OF THE NUCLEAR DATA CENTER. Translation of selected articles from Byull. Tsentra Yadern. Dannym; No. 6, 7-31; 189-211; 215-71; 289-95; 319-90; 407-20(1969). 182p. NTIS.

Separate abstracts were prepared for the seven articles included. (J.W.R.)

For abstracts of individual papers see: 13939, 14005, 14086, 14193, 14194, 14556, and 14557.

14193 (JPRS–54305, pp 1-26) RESONANCE PARAMETERS OF FISSIONABLE NUCLEI (REVIEW). Luk'yanov, A. A. Translated from Byull. Tsentra Yadern. Dannym; No. 6, 7-31(1969).

The features of neutron cross sections of fissionable nuclei in the resonance energy region are discussed. Techniques for representing the energy structure of the cross sections in terms of resonance parameters are reviewed. A large amount of experimental data are surveyed. (56 references) (J.W.R.)

14194 (JPRS–54305, pp 63-91) CALCULATION OF CROSS SECTIONS OF ELASTIC AND INELASTIC SCATTERING OF NEUTRONS WITH ENERGIES E_n = 2-6 MeV BY ATOMIC NUCLEI. Aver'yanov, I. K.; Savel'ev, A. E.; Dzyuba, B. M. Translated from Byull. Tsentra Yadern. Dannym; No. 6, 236-65(1969).

The applicability of the Hauser–Feshbach method for calculating neutron scattering cross sections is tested over a broader neutron energy range and for a larger number of nuclei than has previously been attempted. Optical-model parameters were determined which may be used in calculating cross sections for which no experimental data is available. The available experimental data were compared with the calculations. In general, a good agreement was found. (J.W.R.)

14195 (KFK–1420) "ABC": A COMPUTER PROGRAM FOR ANALYZING THE ELASTIC AND INELASTIC SCATTERING ON THE BASIS OF THE AUSTERN–BLAIR THEORY. Specht, J.; Schweimer, G. W. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Jun 1971. 58p. (In German). Dep. NTIS (U. S. Sales Only).

A computer code is described for analyzing experimental angular distributions of elastic and inelastic scattering in the frame of the Austern–Blair theory. Multiple excitations are considered in the elastic channel, too, in contrast to earlier applications of this theory. The spectroscopic information is obtained by computing the elastic and inelastic angular distributions in a coupled manner. The program structure is especially suited for parameter fitting. In order to save computing time, several parts of the code will be repeated only if the corresponding parameters are varied. The input data for the code are organized in such a way, that unnecessary repetitions are avoided. The program was checked by comparison with calculations performed using other codes for the Austern–Blair theory. In a first application of this program it is shown, that for 104-MeV α-particle scattering the Austern–Blair analysis leads to nearly identical values of the deformation parameters as extracted from a coupled-channel analysis. (auth)

14196 (KFKI–71-55) PROMPT FISSION NEUTRON SPECTRA. Kluge, Gy. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1971]. 24p. Dep. NTIS (U. S. Sales Only).

Some of the main features of the present theoretical understanding of the fission neutron spectra are discussed. The effect of a possible center-of-mass anisotropy and the validity of Terrells $\overline{T}(\overline{\nu})$ relation are discussed. Results of some calculations on the prompt fission neutron spectra are given. (auth)

14197 (LBL–500, pp 371-4) PARAMETERIZATION OF SPIN CORRELATION EXPERIMENTS. Ohlsen, Gerald G.; Keaton, P. W. Jr. (Los Alamos Scientific Lab., N. Mex.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

Suitable definitions of the spin correlation coefficients in terms of Cartesian operators for cases involving spin-1 and spin-½ particles are presented. (auth)

14198 (LBL–500, pp 375-9) CHOICE OF COORDINATE SYSTEMS FOR POLARIZATION EXPERIMENTS. Ohlsen, Gerald G. (Los Alamos Scientific Lab., N. Mex.). 1971.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

There is presented an extension of the "Madison convention" to experiments in which the polarization of more than one particle is measured. A key point is that the momentum of the particle whose polarization is known, whether it is the projectile or the target, should be used to define the coordinate system. The advantages and disadvantages of the projectile helicity frame system and the individual-particle helicity frame system for polarized-beam–polarized-target experiments are discussed. Although the relations between the two systems are trivial, it is extremely important that the one being used be stated. Finally, it is necessary to state precisely which particle is considered as the outgoing particle in reactions of the type a + b → c + d (as opposed to the scattering case, where the identification is obvious). (5 figures). (R.W.R.)

14199 (NP–19041) BEST PARAMETER SEARCH IN ASYMMETRIC ROTOR MODELS. Abecasis, S. M.; Hernandez, E. S. (Instituto de Investigacion Aeronautica y Espacial, Buenos Aires (Argentina)). Jun 1970. 25p. (LR–28). Dep. NTIS (U. S. Sales Only).

The Davydov model is analyzed by performing a least-squares fit to the experimental energy levels simultaneously varying the parameters until an optimum adjustment is obtained. Special emphasis is put on the feasibility of the method proposed to explain the higher vibrational states. The best parameters and the predicted energy sequences are presented for some typical nuclei. The results show that energy levels of deformed nuclei can be reasonably well explained by the Davydov model. Comparison with other models is also made. The use of more realistic potentials in the phenomenological models is encouraged. (auth)

14200 (NP–19043) NUCLEAR MATRIX ELEMENTS FOR THE $\frac{1}{2}^- \rightarrow \frac{1}{2}^+$ TRANSITION IN ^{141}Ce. Bosch, H. E.; Behar, M.; Cambiaggio, M. C.; Bermudez, G. Garcia; Szybisz, L. (Instituto de Investigaciones Aeronauticas y Espaciales, Buenos Aires (Argentina). Laboratorio de Radiaciones. Buenos Aires Univ. (Argentina). Departamento de Fisica). Dec 1970. 9p. (LR–33). Dep. NTIS (U. S. Sales Only).

A search for the nuclear matrix elements corresponding to the non-unique first forbidden transition $\frac{1}{2}^- \rightarrow \frac{1}{2}^+$ from the decay of ^{141}Ce was undertaken. Besides the experimental data available, further measurements were performed on this transition in order to handle at least four observables, i.e., shape factor, beta-gamma

angular correlation, beta-gamma circular polarization, and electrons emitted from oriented nuclei. Bounded values for those matrix elements were found, which do not satisfy the ξ-approximation. (auth)

14201 (OU-LNS-71-8) CENTRIFUGAL STRETCHING EFFECT TO INTRA-BAND E2-TRANSITION RATES. Takemasa, Tadashi; Sano, Mitsuo (Osaka Univ. (Japan). Lab. of Nuclear Studies). [1971]. 14p. Dep. NTIS (U. S. Sales Only).

The angular momentum projection method is applied to the calculation of the intra-band B(E2)-transition rates of even nuclei in the rare-earth region. It is shown that the centrifugal stretching model can reproduce the experimental results for the transitions in the higher spin states of the ground state rotational band with satisfying accuracy. (auth)

14202 (RT/FI-(71)11) MIMOC: A FORTRAN PROGRAMME FOR THE COUPLED-CHANNEL CALCULATION OF THE NUCLEON SCATTERING ON EVEN-EVEN NUCLEI WITH A MICROSCOPIC DESCRIPTION OF TARGET STATES. Fabbri, F.; Marangoni, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 37p. Dep. NTIS (U. S. Sales Only).

The description is given of the MIMOC code written for an IBM 7094 computer in FORTRAN IV language. The program calculates the cross section for incident nucleons on even-even nuclei with a microscopic description of target states. (auth)

14203 (UCRL-18975) TABLES OF CLEBSCH-GORDAN COEFFICIENTS FOR ODD AND EVEN-MASS DEFORMED NUCLEI. Gorman, David J.; Asaro, Frank (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1969. Contract W-7405-eng-48. 565p. Dep. NTIS.

These tables were prepared as a convenient source of the Clebsch-Gordan coefficients commonly used in the calculation of nuclear transition probabilities for deformed nuclei. They are more complete than several previous compilations as they include initial spins up to 16, changes in angular momentum up to 6, and negative values of KF. (auth)

14204 (UR-875-360) PION AND KAON ABSORPTION BY NUCLEI. Koltun, Daniel S. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 4 Oct 1971. Contract AT(30-1)-875. 21p. (CONF-710911-10). Dep. NTIS.

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

Recent experimental and theoretical work on the absorption of pions and kaons by nuclei is reviewed. (J.F.P.)

14205 STUDY OF THE EQUATIONS OF MOTION METHOD FOR NUCLEAR STRUCTURE PHYSICS. Huang, Wei-chung. Cleveland; Case Western Reserve Univ. (1971). 53p. University Microfilms Order No. 71-22,811.

Thesis.

A study of a new formulation of the equations of motion method without "backward" amplitudes for odd-mass vibrational nuclei is presented. By using the results of the exact shell model calculations for the even-even nuclei, ^{58}Ni and ^{60}Zn, the equations of motion have been solved for their neighboring nuclei, ^{59}Ni, ^{59}Cu, ^{61}Zn and ^{61}Ga, with various truncations in the states of the even-even nuclei. The results are compared with those of the shell model calculations for the same odd-mass nuclei. Self-consistent calculations have also been performed for ^{59}Ni and ^{59}Cu by using the knowledge acquired from examining the calculations with the exact inputs. It turns out that the presence of spurious solutions and truncation errors is crucial. The spurious solutions are found to be associated with incorrect isospins and become strongly admixed with physical solutions when the states of the even-even nuclei are truncated. (Diss. Abstr. Int., B)

14206 SYSTEMATICS OF NUCLEON TRANSFER BETWEEN HEAVY IONS AT LOW ENERGIES. Buttle, P. J. A.; Goldfarb, L. J. B. (Univ. of Manchester, Eng.). Nucl. Phys.; A176: No. 2, 299-320(1971).

A discussion is presented of the important dynamical factors influencing the yield in heavy-ion transfer reactions at energies below the Coulomb barrier together with illustrations of calculations for various targets and beams. It is found that the distances of closest approach of the ions before and after the reaction should be similar if cross sections are not to be extremely small. Consideration is given to the implications of this requirement as regards possible experimentation. Recoil effects are found to be important, especially for beams incident on very heavy targets and a technique is suggested for including these effects in the DWBA formalism. (auth)

14207 JASTROW CORRELATIONS. Gaudin, M.; Gillespie, J.; Ripka, G. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Phys.; A176: No. 2, 237-60(1971).

A perturbation expansion is developed of the one- and two-body correlation functions, calculated with a Jastrow wave function in terms of linked diagrams. The method is applied to a critical study of the effect of correlations on one-body operators such as the charge form factors. Brueckner and Jastrow correlations are compared. The inclusion of the Pauli operator in the Jastrow correlation factor as well as the use of oscillating correlation factors are shown to modify the effect of correlations appreciably. (auth)

14208 MOMENTUM SPACE CALCULATIONS AND HELICITY FORMALISM IN NUCLEAR PHYSICS. Erkelenz, K.; Alzetta, R.; Holinde, K. (Univ., Bonn). Nucl. Phys.; A176: No. 2, 413-32(1971).

With the aid of the free reaction matrix, R, and the Brueckner-Goldstone reaction matrix, G, the two-nucleon scattering and nuclear matter problem is presented in the helicity-state formalism. The helicity- and partial-wave-state matrix elements of the most general nucleon-nucleon potential given in the momentum space are calculated. (auth)

14209 FINITE NUCLEAR SIZE EFFECTS IN FERMI β-DECAY. Jaus, W. (Univ., Zurich). Nucl. Phys.; A177: No. 1, 70-80(1971).

Corrections due to the finite extension of the nucleus are calculated for the Fermi function tabulated in the new Landolt-Börnstein series where the Fermi function is evaluated for a finite charge distribution, but under the assumption of a point isovector charge distribution. The corresponding correction is treated in a power series up to and including terms of order $Z^2\alpha^2$, and ft values which contain the integrated effect of the extended nuclear size are obtained. Finally, effective ft values which include the model-independent part of the radiative corrections of order α for some Fermi transitions are discussed. (auth)

14210 JASTROW WAVE FUNCTION AND THE N-BODY CLUSTER PROBLEM IN NUCLEAR MATTER. Lassey, K. R.; Sprung, Donald W. L. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A177: No. 1, 125-44(1971).

Day's derivation of the Jastrow wave function for an N-particle cluster in an interacting Fermi gas is generalized to the case where on-energy-shell interactions are distinguished from off-energy-shell interactions. A simple diagrammatic interpretation allows the derivation of correlated wave functions required to compute the N-body cluster energy. In the four-body case, Day's wave function is found to be wrong and is corrected. The four-body cluster including tensor interactions is considered briefly as another application of the method. (auth)

14211 INFLUENCE OF OCTUPOLE VIBRATIONS ON THE FISSION OF SUPERHEAVY NUCLEI. Fraser, Robert; Greiner, Walter (Univ., Frankfurt am Main). Nucl. Phys.; A177: No. 1, 174-96(1971).

Potential-energy surfaces were calculated for cylindrically symmetric quadrupole (a_{20}) plus cylindrically symmetric octupole (a_{30}) deformations for superheavy nuclei, in the regions of relative stability against spontaneous fission. Using perturbation theory the stiffness and mass parameters of these nuclei for all octupole (a_{3m}) modes of deformation as a function of a_{20} were calculated. It was found that oblately quadrupole deformed nuclei are very unstable against the a_{33} mode of deformation. The importance of this for ternary fission is discussed. The influence of the variation in the zero-point energy of octupole vibrations on the prolate fission barrier is also considered. (auth)

14212 DEUTERON OPTICAL-MODEL POTENTIAL. Simbel, M. H.; Abul-Magd, A. Y. (Cairo Univ., Egypt). Nucl. Phys.; A177: No. 1, 322-36(1971).

Relations between the volume integrals and square radii of proton, neutron and deuteron optical-model potentials are derived assuming the validity of the Watanabe model. These relations are checked by calculating the above-mentioned quantities for the phenomenological optical potentials. The Glauber theory is then used to derive an expression for the deuteron optical potential in terms of the optical potentials of its constituent nucleons which is reduced to the Watanabe approximation when the distortion of the deuteron is neglected. Corrections to the Watanabe model are evaluated in this way and the influence on the volume integrals and mean square radii of the real and imaginary parts of the deuteron potential is investigated. (auth)

14213 SOME PROBLEMS IN NUCLEAR REACTION CALCULATIONS. Schmid, E. W.; Schwager, J. (Univ., Tuebingen, Ger.). Nucl. Phys.; A180: No. 2, 434-48(1972).

Convergence problems arise in nuclear reaction theories when

approximate wave functions are used to describe the internal motion of composite particles involved in the reaction. Implications on the results of a reaction calculation are discussed and models with unique solutions are defined. Some tentative criteria are given as to which model might have solutions similar to the ones obtained with exact channel functions. A least-squares method for linear parameter variation which does not show spurious singularities is also discussed. (auth)

14214 DEUTERON STRIPPING ON DEFORMED NUCLEI. Schulz, H.; Wiebicke, H. J.; Gareev, F. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; A180: No. 2, 625-37(1972).

The coupled-channel Born approximation (CCBA) is applied to the description of deuteron stripping on ^{24}Mg and ^{176}Yb using deformed bound state functions which are expanded in terms of Sturmian functions. The optical and deformation parameters are adjusted by coupled channel calculation from the elastic and inelastic scattering data. Such extended CCBA calculations are found to be important in many instances. (auth)

14215 PION CHARGE-EXCHANGE SCATTERING ON NUCLEI AND ISOBARIC ANALOG RESONANCES. Charlton, L. A. (Univ. of Virginia, Charlottesville); Eisenberg, J. M.; Jones, W. B. Nucl. Phys.; A171: No. 3, 625-30(1971).

A discussion of the theory of the (π^+, π^0) reaction and its usefulness for the study of isobaric analog resonances in certain nuclei is presented. (auth)

14216 PRE-EQUILIBRIUM STATISTICAL MODEL: DESCRIPTION OF THE NUCLEAR EQUILIBRATION PROCESS AND PARAMETERIZATION OF THE MODEL. Cline, C. K.; Blann, M. (Univ. of Rochester, N. Y.). Nucl. Phys.; A172: No. 2, 225-59(1971).

The model proposed by Griffin has been used to investigate the approach of a compound nucleus to statistical equilibrium. A set of master equations describing the equilibration process and utilizing Williams' transition-rate expressions are presented. These equations have been used to study the occupation probabilities and the instantaneous and time-integrated particle energy spectra as a function of the time elapsed from the initial target-projectile interaction. Comparisons of the results for a sample system formed with three excitons at excitation energies of 24 and 96 MeV are presented. The sensitivity of the results of the pre-equilibrium model to changes in the values of the model parameters used has been investigated. In addition, particle spectra resulting from closed-form and master-equation calculations are compared, as are the results obtained using several approximate sets of transition-rate expressions for closed-form calculations. The consequences of using different forms for the state density of the system have also been investigated. Finally, a fairly large number of published experimental particle energy spectra have been analyzed in terms of the pre-equilibrium model. Initial configurations consisting of three particles and holes for nucleon-induced reactions and five particles and holes for ^{4}He ion induced reactions were generally indicated by these analyses. Additionally, it is found that pre-equilibrium particle emission probably accounts for tens of percent of the total reaction cross section. Results of the data analysis are all generally consistent with other recent work on the pre-equilibrium statistical model. (auth)

14217 ANOMALOUS E2 MATRIX ELEMENT. Lawson, R. D. (Argonne National Lab., Ill. Oxford Univ). Nucl. Phys.; A173: No. 1, 17-31(1971).

It is shown that nuclear states describable by the particle-hole configuration $(\pi j)^n (\nu j)^{-n}$ have quadrupole moments and some E2 transition-rate matrix elements proportional to $(e_p - e_n)$. Since the neutron and proton polarization charges are expected to be comparable, $(e_p - e_n)$ should be close to the free-proton charge and hence any marked deviation from the single-particle value for these matrix elements will provide evidence for configuration mixing over and above that included by the effective-charge concept. The consequences of this result, particularly for the $f_{\frac{7}{2}}$ nuclei, are examined. It is also shown (i) that all nuclear states describable by the configuration $(\pi j)^n (\nu j)^{\pm n}$ should have constant g-values, provided the effective M1 operator is state independent, and (ii) that M1 transitions between states with the same "signature" should be forbidden in these nuclei. The level scheme of ^{48}V is predicted on the basis of the pure $f_{\frac{7}{2}}$ model. A simple expression is given for calculating the excitation energy of the core-excited 0^+ states. Several experiments which would clarify the theoretical situation are suggested. (auth)

14218 RESONANCE WAVE FUNCTIONS AND RESONANCE PARAMETERS FROM THE COUPLED-CHANNEL METHOD. Mahaux, C. (Univ., Liege); Sarius, A. M. Nucl. Phys.; A177: No. 1, 103-24(1971).

The behavior of the many-particle scattering wave function in the vicinity of a resonance is studied in the frame of the shell-model approach to nuclear reactions. The possibility of defining a meaningful wave function for a resonance is discussed. It is exhibited that the resonance wave function can be described, like in the bound state case, by configuration mixing coefficients which, however, are complex and correspond to single-particle resonances as well as to bound states embedded in the continuum. It is shown how the configuration mixing coefficients and the parameters of the resonances (total width, complex partial widths, resonance energy) can be extracted from the coupled-channel method. Two methods are proposed. Their flexibility is emphasized and exhibited in the example of the main peak of the giant dipole resonance in ^{40}Ca. The results are compared with those obtained from a standard bound state description of that resonance. (auth)

14219 TOTAL BINDING ENERGIES OF NUCLEI AND PARTICLE-REMOVAL EXPERIMENTS. Koltun, Daniel S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 28: No. 3, 182-5(17 Jan 1972).

Under the assumptions of the impulse approximation, there is a relation between the cross section for removing a particle from a system and the total binding energy of the system if it is bound by two-body forces. This relation is established and applied to the (p, 2p) reaction on nuclear targets. Data from recent experiments are used to obtain values for the total binding energy of the protons in various nuclei, which are then compared with the measured values. (auth)

14220 OPTICAL PUMPING OF RADIOACTIVE ATOMS. Otten, E. W. (Univ., Heidelberg). pp 113-25 of Atomic Physics 2. /Sandars, P. G. H. (ed.). London; Plenum Press (1971).

From second international conference on atomic physics; Oxford, England (21 Jul 1970).

Among matters discussed are the following: Optical pumping of radioactive alkalies produced from noble gas atoms (experimental work; isotope production in the optical pumping vessel; spin-exchange relaxation by free electrons; spin-exchange polarisation by optically pumped Rb; β-decay asymmetry; resonances in ^{37}K and their results; time dependence of asymmetry; experimental work on ^{20}Na); extension to other production schemes (spin exchange polarisation of ^{8}Li recoil nuclei; optical pumping of isotopes far from β-stability; project for fission isotopes). (25 references) (UK)

14221 SPIN DEPENDENT DEUTERON–NUCLEUS INTERACTION CAUSED BY THE COUPLING TO STRIPPING CHANNELS. Rawitscher, George H.; Mukherjee, Shankar N. (Univ. of Connecticut, Storrs). Ann. Phys. (N. Y.); 68: No. 1, 57-93(Nov 1971).

Previously employed coupled equations which describe the dissociation and (recombination) of the incident deuteron into (and from) the stripping channels are reformulated in order to include the spins of the proton, deuteron, and the final nucleus involved in the reaction. The effects of nonorthogonality of the incident and the reaction channel are still ignored in the present formulation, as well as the effects due to deuteron breakup. Attention is focused on the spin–orbit character of the nonlocal deuteron–nucleus interaction which results from the presence of the coupling to the spin-dependent stripping channels. A numerical application to the case of 11-MeV deuterons incident on ^{40}Ca is presented. It is found that roughly half of the vector polarization in the deuteron channel arises from the coupling to the stripping channels. The experimental j dependence of the stripping transition to the $2p_{\frac{1}{2}}$ and $2p_{\frac{3}{2}}$ states in ^{41}Ca near 100° is not reproduced, and the numerical study suggests that inclusion of deuteron-breakup channels into the coupled equations is required. (auth)

14222 QUANTUM THEORY OF NUCLEON CORRELATION IN FINITE NUCLEI. I. HARTREE–FOCK APPROXIMATION AND INDEPENDENT-PAIR MODEL. Szasz, Levente; Schroeder, John (Fordham Univ., New York). Ann. Phys. (N. Y.); 68: No. 1, 1-17(Nov 1971).

A method for the calculation of the approximate solution of the Schroedinger equation of finite fermion systems is described. The method consists of approaching the exact solution in successive approximations. The first step is a Hartree–Fock calculation; the second step is the calculation of two-particle correlation effects; in each successive step higher-order correlation effects are taken into account. For the description of correlation effects, two-particle, three-particle, etc., correlation functions are introduced; these are determined from equations derived using the variational method. At each step the calculated energy is an upper limit to the exact solution. The present paper treats the Hartree–Fock approximation and the two-particle correlation

effects; higher-order effects will be treated in the second part. (auth)

14223 THEORY OF ISOBARIC ANALOG RESONANCES. Auerbach, Naftali; Huefner, Joerg; Kerman, A. F.; Shakin, C. M. (Massachusetts Inst. of Tech., Cambridge). Rev. Mod. Phys.; 44: No. 1, 48-125(Jan 1972).

A theory of analog resonances is reviewed which makes use of projection operators. The Hilbert space is divided into three parts: a continuum or open-channel space, an analog-state space, and a compound space. The phenomena are discussed in terms of the dynamical coupling of these spaces. The parameterization of the T matrix is discussed in detail, and equations are presented for various cross sections. The commutator $[H,T_-]$, where T_- is the isospin-lowering operator, plays an important role in the theory; and the various terms that contribute to this commutator are discussed. The energy splitting of the isospin multiplet, i.e., the Coulomb displacement energy, is discussed in detail. The importance of the analog resonance phenomena for the extraction of spectroscopic information is stressed, and it is shown how such information may be obtained. Various processes that contribute to the escape amplitude of the analog state are classified, and some numerical estimates are given. For several regions of the Periodic Table, graphs are presented for the various theoretical escape amplitudes, continuum energy shifts, asymmetry phases, and optical phase shifts, etc. Spectroscopic factors are calculated and compared with those obtained in other experiments. (auth)

14224 INTRINSIC QUADRUPOLE MOMENTS AND SHAPES OF NUCLEAR GROUND STATES AND EXCITED STATES. Kumar, Krishna (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 28: No. 4, 249-53(24 Jan 1972).

A new method of determining nuclear shapes is proposed which avoids the assumption of a specific nuclear model. The concept of an equivalent ellipsoid, whose charge and moments equal those of the nucleus, is employed. But the method is equally valid for spherical, deformed, and intermediate nuclei. It can be employed for any nucleus (even–even, odd-A, or odd–odd) provided enough E2 matrix elements are available. The example of ^{152}Sm is discussed. (auth)

14225 ANNUAL REVIEW OF NUCLEAR SCIENCE. VOLUME 21. Segre, Emilio (ed.). Palo Alto, Calif.; Annual Reviews Inc. (1971). 442p.

Separate abstracts were prepared for each of the 8 papers. Some related articles appearing in other annual reviews are listed. (M.C.G.)

For abstracts of individual papers see: 11742, 11909, 11990, 12127, 13699, 14156, 14226, and 14227.

14226 WEAK COUPLING STRUCTURE IN NUCLEI. Arima, Akito (State Univ. of New York, Stony Brook); Hamamoto, Ikuko. Annu. Rev. Nucl. Sci.; 21: 55-92(1971).

The nucleus exhibits many characteristic modes of motion. In many cases two modes of motion coexist and interact with each other, but the interaction between the two different modes is often weak compared with intrinsic excitations of each subsystem. The coupling between two modes of motion is discussed from the standpoint of the weak-coupling model. One-particle–one-hole and then many-particle–many-hole states are considered. Particle–vibration coupling is discussed as an example of weak coupling. The strength of the coupling between two different collective modes is investigated. (8 figures, 17 tables, 76 references). (R.W.R.)

14227 THEORY OF NUCLEAR MATTER. Bethe, H. A. (Cornell Univ., Ithaca, N. Y.). Annu. Rev. Nucl. Sci.; 21: 93-244(1971).

A comprehensive review of the theory of nuclear matter, for both infinite nuclear matter and finite nuclei, is given. Various phenomenological nuclear potentials are first presented; and then the only theoretical method that has so far proved adequate and successful in getting results, that of Brueckner and Goldstone, is described. Results for the two-body interaction are discussed. Additional topics covered are the saturation of nuclear forces, three- and four-body correlations, three-body forces, the total energy of nuclear matter, the symmetry energy, and neutron matter (with application to neutron stars). The section on finite nuclei begins with a comparison of finite and infinite nuclei. With the nucleus described by shell-model wave functions, an effective interaction between nucleons is needed to express the energy of the entire nucleus. Density-dependent Hartree–Fock theory is treated by using the effective interaction obtained. Oscillator-basis Brueckner theory, in which nuclear matter calculations are done using a single oscillator function for each nucleon, is explained. Various alternative methods for doing nuclear-matter calculations are considered. Discussions of the Thomas–Fermi method and the interaction of nucleons within a shell conclude the paper. (34 figures, 25 tables, 211 references). (R.W.R.)

14228 SHELL-MODEL CALCULATIONS FOR A = 6, 7, 8, AND 9 WITH THE SUSSEX MATRIX ELEMENTS. Cooper, Benjamin S.; Seaborn, J. B.; Williams, S. A. (Ames Lab., Iowa). Phys. Rev., C; 4: No. 6, 1997-2002(Dec 1971).

Normal-parity states of the A = 6, 7, 8, and 9 systems are calculated within the framework of the $(0p)^{A-4}$ shell-model basis. The two-nucleon interaction matrix elements deduced by the Sussex group are used to compute the interactions between 0p-shell particles as well as the interactions of individual 0p-shell particles with the $(0s)^4$ core. The only adjustable parameter in the calculation is the oscillator length associated with the shell-model basis, although the range of acceptable values for this parameter is limited by the experimental rms radius for the nucleus under consideration. The agreement between calculated and experimental energy levels is poor. However, a strengthening of the $^3S_1$ interaction greatly improves the results. (auth)

14229 ORIGIN OF DAMPING OF WAVE FUNCTIONS IN THE NUCLEAR INTERIOR. Schenter, R. E. (WADCO Corp., Richland, Washington); MacKellar, A. D. Phys. Rev., C; 4: No. 6, 2020-9(Dec 1971).

The damping of single-particle wave functions, using nonlocal potentials derived in the Hartree–Fock (HF), and no-polarization approximations with respect to wave functions obtained from "equivalent" local potentials is investigated for low-energy n–^{16}O scattering. It is found that strong damping due to the HF exchange term occurs only if the basic nucleon-nucleon interaction is nonlocal; when local interactions are used, a small amount of antidamping occurs. A study is made of the effect of adding two-body correlations to the ground-state target wave function, where it is found that strong damping effects occur for local nucleon-nucleon interactions. (auth)

14230 EFFECTS OF NUCLEON-PAIR CORRELATIONS ON MONTE CARLO INTRANUCLEAR-CASCADE SIMULATIONS. Chen, K.; Friedlander, G.; Harp, G. D.; Miller, J. M. (Brookhaven National Lab., Upton, N. Y. Columbia Univ., New York). Phys. Rev., C; 4: No. 6, 2234-40(Dec 1971).

The effects of short-range nucleon correlations have been included in intranuclear-cascade calculations in an approximate manner. Comparisons are made with earlier calculations and with experiments. The agreement with experimental data on spallation reactions and spectra of emitted protons is systematically improved when the nucleon-correlation effect is included, along with refraction and reflection at potential boundaries and with a velocity-dependent potential. (auth)

14231 FRAGMENT-SHELL INFLUENCES IN NUCLEAR FISSION. Mosel, Ulrich (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville); Schmitt, H. W. Phys. Rev., C; 4: No. 6, 2185-2201(Dec 1971).

Potential-energy surfaces and shell-correction-energy surfaces for nuclei in the $A \simeq 200$ region and for actinides ($A \gtrsim 230$) have been calculated in the improved two-center model. These surfaces are shown in a two-dimensional representation as a function of the elongation and the constriction of the nuclear shape. Both the ground-state shell corrections and the fission barriers in the $A \cong 200$ region agree well with experiment. It is found that the saddle-point position in this region is shifted significantly towards smaller deformations compared with the liquid-drop-model prediction, this shift arising from a very pronounced valley in the shell-correction surface at the position of the liquid-drop-model saddle point. The implications of this finding for a nuclear mass formula and for the application of the liquid-drop model to fission of these nuclei are discussed. In both mass regions ($A \cong 200$ and $A \gtrsim 230$) the shell corrections alone show pronounced structure which changes slowly with mass number. At small deformations, up to the region of the second maximum in the potential, this structure is determined by the compound-nucleus shell structure. At larger deformations this structure is shown to arise from the shell structure of the nascent fragments, thus establishing the importance of fragment shells early in the fission process for the entire mass range $A \gtrsim 200$. As a consequence of these studies the regions of validity for the liquid-drop model in describing nuclear fission are explained. Finally, it is shown that the recently observed symmetry in the mass distribution of ^{257}Fm is due to the approach to the nucleus ^{264}Fm, which can split symmetrically into the two energetically strongly favored ^{132}Sn nuclei. (auth)

14232 TENSOR FORCE AND THE BOUNDARY-CONDITION-MODEL T MATRIX. Fuda, Michael G. (State Univ. of New York, Buffalo). Phys. Rev., C; 5: No. 1, 275-7(Jan 1972).

The relation between the half-off-shell T matrix, the on-shell T matrix, and the two-particle wave function is generalized to the fully-off-shell T matrix and tensor forces. The new relation is used to derive the boundary-condition-model T matrix when tensor coupling is present. (auth)

14233 TWO-BODY INTERACTIONS: THE METHOD OF CORRELATED QUASIPARTICLES. I. Chasman, R. R. (Argonne National Lab., Ill.). Phys. Rev., C; 5: No. 1, 29-35(Jan 1972).

A method is proposed for determining the ground state of the Hamiltonian $H = \Sigma_k \epsilon_k N_k - \Sigma_{ijkl} V_{ijkl} a_i^\dagger a_j^\dagger a_k a_l$ when the residual interaction is such that $\langle a_i^\dagger a_j^\dagger a_k a_l \rangle = \langle N_i N_j (1-N_k)(1-N_l) \rangle^{1/2} \langle N_k N_l (1-N_i)(1-N_j) \rangle^{1/2}$ is a good approximation. The method is applied to pairing interactions involving one type of nucleon as well as to the generalized pairing problem containing neutron–neutron, neutron–proton, and proton–proton interactions. (auth)

14234 THREE-BODY CLUSTERS IN NUCLEAR MATTER. da Providencia, Joao; Shakin, C. M. (Univ., Coimbra). Phys. Rev., C; 5: No. 1, 53-9(Jan 1972).

It is shown that starting with a correlated wave function for nuclear matter of a general form enables one to make direct correspondence to the conventional diagrammatic theory of Brueckner, Bethe, and Goldstone; in particular, it is shown that the expression for the three-body-cluster energy is the same as that obtained by Bethe. Also, it is shown that the current approximation, which neglects the potential for particle states in the diagrammatic approach, corresponds to a neglect of a coupling between the two-body (Bethe–Goldstone) equation and the equation for the three-body-cluster wave function (Bethe–Faddeev). The theory presented here provides a clarification of the relation of the n-body-cluster wave functions and the structure of the wave function of the entire system. (auth)

14235 METHOD TO INVESTIGATE THE OFF-SHELL EFFECTS OF THE HIGH-ENERGY PART OF THE TWO-NUCLEON INTERACTION. Monahan, J. E. (Argonne National Lab., Ill); Shakin, C. M.; Thaler, R. M. Phys. Rev., C; 5: No. 1, 59-62 (Jan 1972).

Two classes of two-body Hamiltonians are constructed such that the energy eigenfunctions of the members of each class are identical below some cutoff energy E_c. In one class the phase shifts for energies greater than E_c remain fixed for all Hamiltonians in the class, although the corresponding eigenfunctions are different for small distances of separation. In the other class the phase shifts for the various members of the class also differ for energies greater than E_c. (auth)

14236 BETHE–GOLDSTONE EQUATION IN FINITE NUCLEI. Demos, Joslyn R.; Banerjee, Manoj K. (Univ. of Maryland, College Park). Phys. Rev., C; 5: No. 1, 75-84(Jan 1972).

After setting QUQ = 0, where U is the single-particle potential, the Bethe–Goldstone equation becomes $\Psi = \Phi - [Q/(QTR - \omega]v\Psi$. This equation is approximated by replacing Q with Eden–Emery Pauli operator and by neglecting $\hat{T}\chi$, where $\hat{T}$ is the off-diagonal part of the c.m. kinetic energy operator in the oscillator representation. Care is taken to retain $T\Phi$, which is a large term. The approximate equation is solved iteratively. It yields defect functions with the bulk of the effect of Q built in. Correction terms to the approximate results are estimated. A very satisfactory feature of the present approach is that there is considerable cancellation between the so-called spectral and Pauli correction terms. The biggest correction term is $\langle\chi|\hat{T}|\chi\rangle$, which can be as large as 0.5 MeV in the triplet-even case. (auth)

14237 ROLE OF ISOSPIN IN STATISTICAL PROCESSES. Grimes, S. M.; Anderson, J. D.; Kerman, A. K.; Wong, C. (Univ. of California, Livermore). Phys. Rev., C; 5: No. 1, 85-94(Jan 1972).

The Hauser–Feshbach formalism is generalized to include isospin. Examination of the consequences of this extension for typical nuclei indicates that significant enhancement in the cross section for emission of protons in proton-induced reactions is predicted. Level widths and densities deduced from fluctuation measurements are also affected. The results of some proton-induced reactions are interpreted in terms of isospin effects; new experiments are proposed which should yield information on isospin mixing and on level widths for states with differing isospin. (auth)

14238 SURFACE DELTA INTERACTION AND SPHERICAL HARTREE–FOCK–BOGOLYUBOV CALCULATIONS. Goswami, Amit; Lin, Lu (Univ. of Oregon, Eugene). Phys. Rev., C; 5: No. 1, 142-44(Jan 1972).

A self-consistent procedure is outlined in which the interaction radius R of the surface δ interaction (SDI) is determined self-consistently from the spherical Hartree–Fock–Bogulyubov (HFB) field it produces. It is shown that, if the surface R is determined this way, the Woods–Saxon single-particle wave functions are more or less equal in magnitude at R, as assumed in earlier works. The procedure is also shown to give numerical results for quasi-particle energies in Ni isotopes in agreement with experimental indications. Thus, the SDI model provides us with an example where the effective interaction is self-consistently determined with the field it produces. (auth)

14239 RELATIVISTIC SELF-CONSISTENT MESON FIELD THEORY OF SPHERICAL NUCLEI. Miller, L. D.; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev., C; 5: No. 1, 241-52(Jan 1972).

A relativistic self-consistent theory is used in conjunction with meson field potentials having the form of the generalized one-boson-exchange potentials (GOBEP) to construct a relativistic self-consistent meson field theory of nuclear structure. A simple GOBEP model with qualitative features of successful N–N models, e.g., approximate cancellation of static terms arising from generalized (or regularized) scalar- and vector-meson fields, is used to calculate ground-state properties of the doubly magic spherical nuclei ^{16}O, ^{40}Ca, ^{90}Zr, and ^{208}Pb, and one superheavy nucleus $^{298}114$. Good agreement is obtained between theoretical and experimental total binding energies and radial charge distributions. The isotopic shift in charge distributions between the isotopes ^{40}Ca and ^{48}Ca and the single-particle eigenvalues agree quite well with the experimental numbers. The absence of explicit correlation corrections, the relationship of this model to earlier meson-theoretic descriptions, and physical interpretation in terms of nucleon form factors and relativistic interactions are discussed. (auth)

14240 EXCITATION OF COLLECTIVE NUCLEAR STATES BY FAST PARTICLES. Bassichis, W. H. (Massachusetts Inst. of Tech., Cambridge); Feshbach, H.; Reading, J. F. Contract AT(30-1)-2098. Ann. Phys. (N. Y.); 68: No. 2, 462-83(Dec 1971).

The elastic and inelastic scattering of a fast particle by a vibrating nucleus is discussed in the semiclassical approximation. For elastic scattering it is shown that the effect of the vibrations can be described by an effective deformed optical potential which is axially symmetric about the incident direction. Explicit results are obtained for inelastic scattering. The validity of the semiclassical approximation for potential scattering is discussed, and numerical tests are made. (auth)

14241 STUDIES IN THE SHAPE DEPENDENCE OF THE DROPLET MODEL OF NUCLEI (CURVATURE AND COMPRESSIBILITY EFFECTS). Hasse, Rainer W. (Univ. of California, Berkeley. Univ., Heidelberg). Ann. Phys. (N. Y.); 68: No. 2, 377-461(Dec 1971).

A study is made of the shape dependence of various terms appearing in the nuclear droplet model of Myers and Swiatecki. The new terms which arise here beyond those encountered in the liquid-drop model are due to the curvature correction to the surface energy, the nuclear compressibility, and the redistribution of the nuclear density caused by the Coulomb force. Shell and pairing energies are omitted because they have their origin in the microscopic rather than the macroscopic structure of nuclei. The shape-dependent droplet model which results is used with a variety of shape parameterizations to calculate nuclear saddle point shapes corresponding to the fission barrier. Various properties of these shapes are given such as the barrier heights, geometrical properties, and normal modes of oscillation. The stability of the reflection symmetric saddle points against asymmetric distortions is also investigated. Of the new terms which enter in this model the only one which has a major influence on the saddle-point properties is the curvature correction to the surface energy. For reasonable estimates of the droplet-model constants the other terms produce only small effects. Large values of the curvature correction coefficient favor the formation of a secondary minimum in the fission barrier of heavy elements. For super-heavy elements this gives rise to the possibility of quasi-molecular states. The Coulomb redistribution energy is shown to favor the formation of asymmetric scission-point configurations. (89 references). (auth)

14242 PROJECTION OF ANGULAR MOMENTUM AND FIXED PARTICLE NUMBER FROM BCS WAVE FUNCTION. Ullah, Nazakat (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., C; 5: No. 1, 285-7(Jan 1972).

The new method of angular projection in which one makes use of the rotation operator in evaluating the matrix of the projection operator but does not have to perform the numerical integrations over the Euler angles is applied to the Bardeen–Cooper–Schrieffer type of wave function, where one has to project both the angular momentum and the given number of particles. (auth)

14243 EXPERIMENTAL STUDY OF THE EFFECTIVE NUCLEON–NUCLEON INTERACTION. Anantaraman, N.; Schiffer,

J. P. (Argonne National Lab., Ill. Univ. of Chicago). Phys. Lett.; 37B: No. 3, 229-32(29 Nov 1971).

Data concerning the level spectra from nuclei in the immediate vicinity of closed shells are found to exhibit certain simple systematic patterns. These are analyzed in terms of the components of an effective residual interaction between nucleons. (auth)

14244 RELATION BETWEEN NUCLEAR MATTER AND NUCLEAR POTENTIAL IN INELASTIC ALPHA–NUCLEUS SCATTERING. Rawitscher, G. H.; Spicuzza, R. A. (Univ. of Connecticut, Storrs). Phys. Lett.; 37B: No. 3, 221-4(29 Nov 1971).

Inelastic transition form factors for alpha-nucleus collective excitations are derived from deformed matter distributions by averaging an effective alpha nucleus interaction over the nucleons in the nucleus. The method is an extension of the procedure of calculating the real part of elastic alpha-nucleus potentials from nuclear matter distributions. Numerical examples for the nuclei of ^{42}Ca and ^{142}Nd are given. The resulting inelastic form factors depend on the multipolarity of the inelastic excitation and differ from those conventionally derived from a deformed optical potential. (auth)

14245 CRITIQUE OF THE COLLECTIVE MODEL OF INELASTIC SCATTERING. Edwards, V. R. W.; Sinha, B. C. (King's Coll., London). Phys. Lett.; 37B: No. 3, 225-8(29 Nov 1971).

The presently accepted formalism for inelastic scattering of nucleons from collective nuclei is based on a deformed optical potential. A simple microscopic model is used to compare this formalism with an alternative formation based on a deformed nuclear density. The results suggest that there are very large differences between the nuclear and the optical potential deformation parameters and that quite different shapes are obtained for the inelastic form factors with these two prescriptions. It is concluded that the accepted collective inelastic formalism may be totally fallacious and that any agreement between its predictions and experiment is perhaps fortuitous. (auth)

14246 CENTRIFUGAL STRETCHING EFFECT TO INTRABAND E2-TRANSITION RATES. Takemasa, T.; Sano, M. (Osaka Univ.). Phys. Lett.; 37B: No. 3, 233-6(29 Nov 1971).

The angular momentum projection method is applied to the calculation of the intra-band B(E2)-transition rates of even nuclei in the rare-earth region. It is shown that the centrifugal stretching model can reproduce the experimental results for the transitions in the higher spin states of the ground state rotational band with satisfying accuracy. (auth)

14247 EFFECT OF EXCHANGE CURRENTS ON ORBITAL g-FACTORS. Fujita, J. I. (Tokyo Univ.); Hirata, M. Phys. Lett.; 37B: No. 3, 237-9(29 Nov 1971).

On the basis of the Fermi gas model a simple relation is derived between the change of orbital g-factors due to exchange currents and the sum rule for E1 photoabsorption. Recent data on static magnetic moments are examined. (auth)

14248 ANALYTICITY OF REGULARIZED INTEGRALS CONTAINING EIGENFUCTIONS WITH COMPLEX MOMENTUM. Berggren, T. (Lund Inst. of Tech., Sweden). Phys. Lett.; 37B: No. 3, 240-2(29 Nov 1971).

It is shown that the regularization procedures of Zel'dovich and of Gyarmati and Vertse converge uniformly and yield analytic matrix elements in a domain of the complex momentum plane which is of interest for the study and use of resonant states. (auth)

14249 COMPARISON OF SPECTROSCOPIC INFORMATION GIVEN BY THE PERIPHERAL MODEL AND DWBA. Borbely, I. (Central Research Inst. for Physics, Budapest). Phys. Lett.; 37B: No. 3, 243-6(29 Nov 1971).

It is shown that the one parameter form of the peripheral model gives the same spectroscopic information as DWBA does for neutron transfer reactions on light nuclei at medium bombarding energies. (auth)

14250 PION–NUCLEUS CHARGE EXCHANGE SCATTERING AT INTERMEDIATE ENERGIES. Rost, E.; Edwards, G. W. (Univ. of Colorado, Boulder). Phys. Lett.; 37B: No. 3, 247-9 (29 Nov 1971).

Single and double charge exchange scattering of pions from nuclei are calculated using the Kisslinger optical potential. The cross sections so obtained are found to depend strongly on the difference between the neutron and proton density distributions in the target nucleus. (auth)

14251 MULTIPLE TRANSFER OF T = 1 PAIRS AND QUADRUPLES IN HEAVY ION COLLISIONS. Eichler, J. Hahn-Meitner-Institut fuer Kernforschung, Berlin. Freie Univ., Berlin). Phys. Lett.; 37B: No. 3, 250-2(29 Nov 1971).

The multiple transfer of J = 0, T = 1 pairs and quadruples in subcoulomb collisions between nuclei of the Ca-region is studied in a semi-classical approximation. (auth)

14252 QUASI-DEUTERON PRODUCTION BY HIGH ENERGY γ-RAYS AND NUCLEAR CORRELATION. Futami, Yasuhiko (Tokyo Univ. Chiba, Japan); Miyazima, Tatsuoki. Progr. Theor. Phys. (Kyoto); 46: No. 3, 802-7(Sep 1971).

The total cross section for direct absorption of high energy photons by neutron–proton pairs is evaluated. It is shown that the theoretical analysis of this reaction gives information about the short-range nuclear pair-correlation function. The results are compared with those obtained from Levinger's theory and the experimental data. (auth)

14253 STRUCTURE OF ANOMALOUS COUPLING (j–1) STATES. Matsuyanagi, Kenichi (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 46: No. 3, 996-8(Sep 1971).

The low-lying, anomalous-coupling (j – 1) states in spherical odd-A nuclei are discussed using the concept of dressed three-quasiparticle excitations. (J.W.R.)

14254 NUCLEON–NUCLEON T-MATRIX FACTORIZATION FOR REALISTIC POTENTIALS. Efimov, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR); Fenin, Yu. I.; Tkachenko, E. G. Phys. Lett.; 37B: No. 3, 269-71(29 Nov 1971).

The nucleon–nucleon T-matrix off energy shell is factorized with respect to momentum variables for potentials with a hard core. The expressions derived give a practical possibility of solving numerically the three-nucleon Faddeev equations. (auth)

14255 CHANNEL COUPLING SCHEME IN THE R-MATRIX THEORY. Luk'yanov, A. A. Teor. Mat. Fiz.; 9: No. 3, 398-405(Dec 1971). (In Russian).

In the resonance theory of nuclear reactions with nucleons the collision matrix is divided into two parts: corresponding to the bound and decaying eigen-states respectively. Treating these parts as the matrix of direct interaction and that of compound resonances respectively, the structure of bound-state widths and the complex potential model are discussed. (auth)

14256 THEORY OF SHELL STRUCTURE AND OF THE MAGIC EFFECT IN SPHERICAL NUCLEI. Nosov, V. G.; Kamchatnov, A. M. Zh. Eksp. Teor. Fiz.; 61: No. 4, 1303-18 (Oct 1971). (In Russian).

A consistent theory of the volume-energy oscillations of spherical nuclei due to sharpness of the Fermi distribution boundary for quasi particles is developed. The lowest value of the oscillating part of the energy corresponds to the magic nucleus. A formula is obtained for the corresponding boundary momentum of a quasi particle, and it is shown that an isolated point of the temperatureless phase transition of the second kind is involved. An expression for the discontinuity of the derivative of the body energy with respect to particle number is obtained in the case of a sharp (step-like) Fermi distribution boundary. Some conclusions can be drawn regarding the true structure of the boundary layer of the Fermi distribution and also of the tendency of its variation with increase of nuclear size by comparing the theory with experimental data on nuclear masses. No evidence of any significant residual phenomena (e.g., the Cooper phenomenon) which could destroy equilibrium of the energy spectrum of infinite nuclear matter with an absolutely sharp Fermi boundary for quasi particles is observed in the accessible magic nuclei region. (auth)

14257 ESTIMATING ALPHA-PARTICLE TRANSMISSION THROUGH A BARRIER. Carjan, N.; Sandulescu, A. (Inst. for Atomic Physics, Bucharest). Z. Naturforsch.; 26a: No. 9, 1389-91(Sep 1971).

Among the numerous doubts associated with the estimation of the alpha-decay penetrabilities, two queries have been selected in order to investigate their justification: is the ambiguous determination of α-nucleus potential a real obstacle and is the JWKB an inadequate approximation? (auth)

14258 CALCULATION OF THE CONDITIONS AT SCISSION POINT IN THE MOST PROBABLE MODE OF TERNARY FISSION. Cavallari, F.; Fossati, F.; Pinelli, T. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Lett. Nuovo Cim.; 2: No. 23, 1217-21(4 Dec 1971).

Numerical results on the state of the stretched nucleus at the scission point in ternary fission with emission of alpha particles are presented. The distance between the centers of the fission fragments, the emission point of the light particle, and the dynamical conditions of the fragments and alpha particles at the instant of separation are evaluated in the three-spherical-charge model. (3 figures, 1 table) (R.W.R.)

PHYSICS (PLASMA AND THERMONUCLEAR)

14259 PLASMA PHYSICS INDEX. VOLUME 6, NO. 11, 1971. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 180p.

A listing is presented of 544 articles on various aspects of plasma physics. (M.O.W.)

14260 ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS. VOLUME 30. Marton, L. (ed.). New York; Academic Press Inc. (1971). 352p. $19.50.

Separate abstracts were prepared for two of the seven chapters presented. The remaining five chapters were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 12140 and 14289.

Confinement and Heating

Refer also to abstract 14314.

14261 (CEA-CONF-1849) DIFFUSION INDUCED BY AN OSCILLATING ELECTROMAGNETIC FIELD IN A TOKOMAK CONFIGURATION. Samain, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 5p. (CONF-711016-4). Dep. NTIS (U. S. Sales Only).

From Conference on plasma theory; Kiev, USSR (19 Oct 1971).

The particle and heat diffusions induced by an oscillating electromagnetic field in a Tokamak configuration were studied. Angular and action variables were used to describe the motion of the particles in the static field and general formulas were developed for the coefficients of the transfer induced by the oscillating field and the power gained by the plasma; the particles interacting irreversibly with the oscillating field are either freely circulating or trapped. This formalism was used to study the control of particle diffusion across the configuration and ultimately the refueling of a fusion reactor. A plasma in the Galeev–Sagdeev region I was considered, neoclassical diffusion being assumed. The most promising aspect is the very-low-frequency compressional magnetic pumping of trapped particles. The refueling of a reactor might be possible using this method, the power dissipated in the plasma being much smaller than the natural plasma energy losses. (France)

14262 CLASSICAL DIFFUSION OF A STATIONARY TOROIDAL PLASMA. Maschke, E. K. (CEN, Fontenay-aux-Roses, France). Plasma Phys.; 13: No. 10, 905-12(Oct 1971).

The classical resistive diffusion of a stationary toroidal plasma is treated on the basis of one-fluid magnetohydrodynamic equations. The Kruskal–Kulsrud conditions for the existence of a stationary solution are generalized to include an external longitudinal electric field. One of these conditions shows that there are unidirectional longitudinal currents associated with the diffusion velocity, even in the absence of an external electric field. A general expression for the mean velocity of diffusion through a magnetic surface is obtained. This expression is applied to different magnetic configurations of the stellarator and tokamak-type by using an expansion in the neighborhood of a magnetic axis. The validity of a formula given by Pfirsch and Schlüter is essentially confirmed (auth)

14263 PLASMA CONVECTION IN TOROIDAL SYSTEM UNDER WEAKLY SUPERCRITICAL CONDITIONS. Pogutse, O. P.; Shutko, A. V. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 13: No. 10, 925-32(Oct 1971).

The laminar convection of plasma which develops through a dissipative instability of localized drift waves is investigated. A nonlinear equation that describes the localized finite-amplitude drift waves is derived. A stationary solution of this equation is found that corresponds to the case of small supercriticality. The plasma flux across the magnetic field is calculated, and an expression for the laminar diffusion coefficient is found. (auth)

14264 ONSET OF STATIONARY CELLS AND IMPROVED PLASMA CONFINEMENT. Cataldo, J. C.; Jaffe, M.; Jen, N. C.; Mansfield, I. (City Coll., New York). Plasma Phys.; 13: No. 10, 989-91(Oct 1971).

A potassium plasma was produced in a single-ended Q-machine with a tungsten plate heated by electron bombardment to 2100 to 2400°K. Langmuir probes were used to obtain saturation ion current and floating-potential profiles and to detect oscillatory instabilities. Visualization of the instantaneous plasma density distribution at the cold end of the column was accomplished using a plasma camera. (UK)

14265 PLASMA TRAPPING IN THE DIVERTER OF A STELLARATOR. Atamanov, N. S.; Biryukov, O. V.; Georgievskii, A. V.; (and others). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 887-92(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1123-30(Jun 1971).

Experiments that concern plasma trapping in the magnetic field of the divertor of a stellarator (Indus) are described. Plasma is injected from a coaxial gun along a tangent to one of the field lines that extend from the stellarator into the divertor chamber. The trapping coefficient, the radial density distribution, and other parameters of the trapped plasma are measured as functions of the fractional modulation of the basic magnetic field by the counter field. Efficient injection of the plasma into the trap is possible with the use of a local pulsed depression of the magnetic field and the injection of plasma in the direction tangent to one of the extended magnetic field lines. (auth)

14266 ENHANCEMENT FACTOR OF COLLISIONAL DIFFUSION NEAR THE RATIONAL SURFACE. Ohkawa, T. (Gulf General Atomic Co., San Diego, Calif.). Contract No. AT(04-3)-167. Phys. Lett.; 38A: No. 1, 21-2(3 Jan 1972).

The diffusion coefficients for a plasma column with a helical magnetic perturbation are calculated. For both classical and neoclassical regimes, the diffusion rate is enhanced near the flux surfaces where (rotational transform angle)/2π is rational. This is due to the fact that the geodesic curvature stays constant along a flux line on the rational surface. The guiding-center drift perpendicular to the flux surface is thus unidirectional. For a low-collision-frequency case, the banana size becomes large. For the collisional regime, it results in a large parallel current. The diffusion rates for both regimes are given by simply replacing the poloidal component of the magnetic field for the axially symmetric case by the component perpendicular to the helix, i.e., $B_\theta + (kr/m)\, B_z$. (auth)

14267 TURBULENT HEATING IN COMPUTER SIMULATIONS OF THE MODIFIED PLASMA TWO-STREAM INSTABILITY. Ott, Edward; McBride, John B.; Orens, Joseph H.; Boris, Jay P. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 28: No. 2, 88-91(10 Jan 1972).

Computer simulations of the fluid-like modified two-stream instability, driven by relative electron–ion drifts across a magnetic field, show strong anomalous plasma heating. The electron and ion heating rates are comparable and result in ion thermal speeds which approach the relative drift speed within a few ion plasma periods. (auth)

14268 EQUILIBRIUM DIFFUSION OF A ROTATING PLASMA IN A TOROIDAL SYSTEM. Shamsutdinov, I. A. (Inst. of Chemistry, Ufa, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 959-62(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1216-21(Jun 1971).

Equilibrium diffusion in a toroidal system is considered, including particle rotation in the self-consistent radial electric field. Ion–ion viscosity, electron temperature perturbations and ion temperature perturbations are treated in the two-fluid hydrodynamic approximation. Because one assumes high electron thermal conductivity and low friction [i.e., $\theta^2 \kappa_\parallel^e \gg r n_0 U_{ni}$, where $\kappa_\parallel^e = 3.16 n T_e / m_e \nu_e$ is the longitudinal electron thermal conductivity; $\theta = ir/2\pi R$, $U_{ni} = (cT_{0i}/en_0 H_0) dn_0/dr$], and that the equilibrium temperatures T_{0e} and T_{0i} are the same, introducing the ion temperature perturbations makes it possible to consider heat exchange between the ions and electrons. The case $dT_{0i}/dr = 0$ is considered. With $T_{0e} = T_{0i}$ it is shown that the calculated equilibrium diffusion is not significantly different from classical Pfirsch–Schluter diffusion for the parameter values studied here. The classical approach to these plasma transport phenomena is justified. (auth)

14269 HEATING AND COMPRESSION OF PLASMAS WITH NONADIABATIC PARTICLE MOTION. Krivets, V. P.; Peregud, B. P. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 928-33(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1174-81(Jun 1971).

Analysis of the motion of charged particles in homogeneous magnetic fields (with axisymmetric boundaries), which increases as a

function of time such that the condition of adiabaticity is strongly violated, shows that the particle motions are singular in character. The distance of each particle from the symmetry axis of the field approaches a constant value as the field is increased. This distance depends on the initial conditions and is equal to the diameter of the circle of gyration for each particle. The particle energy increases in proportion to the square of the field strength. After the growth of the field ceases and a time equal to half the gyration period of the particles has passed, all particles simultaneously pass near the symmetry axis of the field. This collective particle compression is repeated at intervals of a gyro period. (auth)

14270 STATISTICAL HEATING OF ELECTRONS AT AN OSCILLATING PLASMA BOUNDARY. Godyak, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1073-6(Jan 1972).
Translated from Zh. Tekh. Fiz.; 41: No. 7, 1364-8(Jul 1971).

A planar plasma boundary in contact with a wall that is a dc insulator is investigated. The application of a hf voltage to the plasma boundary is assumed. A theoretical analysis for electron heating is then presented. (M.O.W.)

14271 EFFECT OF ACOUSTIC INSTABILITY ON CONFINEMENT IN A MAGNETOPLASMA. Pasechnik, L. L.; Popovich, A. S. (Inst. of Physics, Kiev). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1087-90(Jan 1972).
Translated from Zh. Tekh. Fiz.; 41: No. 7, 1382-5(Jul 1971).

An attempt is made to investigate the transport of charged particles across a magnetic field by means of the phase method developed earlier to analyze the motion of ions in a gas. It is shown that an instability previously identified by the authors as a modification of a longitudinal ambipolar acoustic instability increases the loss rate of particles to the wall. The electron and ion confinement times are of the same order as the oscillation period and agree with estimates based on dimensional considerations. (auth)

Diagnostics

14272 (CONF-711124-2) SPECTROSCOPIC AND PROBE MEASUREMENTS OF EXCITED STATE AND ELECTRON DENSITIES IN RADIATION INDUCED PLASMAS. Thiess, P. E.; Miley, G. H. (Illinois Univ., Urbana). [1970]. 9p. Dep. NTIS.
From second symposium on uranium plasmas; Atlanta, Ga. (15 Nov 1971).

Measurements of excited states and electron densities in noble and atmospheric gas plasmas created by intense sources of nuclear radiation were made. A 1/2-Ci Po-210 alpha particle (5.3 MeV He^{2+}) source with a flux of 10^7 ions/cm^2-sec was used to irradiate cylindrical volumes of both single gases and gas mixtures. Data obtained on He, Ne, Ar, He–N_2, and He–Ne indicates that, for pressures above 10 torr, resonant transfer, collisional mixing, charge exchange, and molecular ion formation are important plasma kinetic processes along with Penning ionization and superelastic collisions which destroy metastable states. Studies of the effect of a superimposed electric field on excited state and electron densities indicate that a field of between 1 and 10 volts/cm-torr tends toward optimum excited-state production. (auth)

14273 (ORO-3393-6) APPLICATIONS OF LIGHT SCATTERING TO PLASMA DIAGNOSTICS. Progress Report. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Nov 1971. Contract AT(40-1)-3393. 18p. Dep. NTIS.

This report consists of status reports on: (1) resonant scattering of radiation from plasmas using tunable dye lasers; (2) investigation of electric field fluctuations in a coaxial plasma gun and in an electron-beam discharge, and (3) investigation of a high-temperature plasma produced in a vacuum spark. (M.O.W.)

14274 USE OF A MULTIPLE-BEAM THREE-PLATE SERIES-TYPE INTERFEROMETER FOR GAS-DISCHARGE INVESTIGATIONS. Polushkina, N. A.; Tendler, M. B. Opt. Spectrosc. (USSR) (Engl. Transl.); 30: No. 4, 402-3(Apr 1971).
Translated from Opt. Spektrosk.; 30: No. 4, 745-8(Apr 1971).

The possibility of using a multiple-beam series-type interferometer to investigate the radial density distribution of neutral atoms in the positive column of an argon discharge is considered. An estimate is made of the sensitivity of the method and of the measurement range. Preliminary data on the radial density distribution of neutral atoms in argon in absolute units are obtained. (auth)

14275 COMPARISON OF LANGMUIR-PROBE AND SPECTROSCOPIC ELECTRON TEMPERATURE MEASUREMENTS. Numano, N.; Furukawa, O.; Michiyoshi, I. (Kyoto Univ.). Plasma Phys.; 13: No. 10, 992-5(Oct 1971).

An experimental confirmation of the deviation from LTE in a low-density argon plasma and the applicability of the theory on the deviation from LTE developed by Griem was considered. The excitation temperature determined spectroscopically using relative intensities of the resonance lines 4000 to 7000 Å of argon atoms was compared with the electron temperature measured by a conventional Langmuir probe. As a result it was found that the excitation temperature was 1000 to 1500°C higher than the electron temperature and that the difference between them increased along the radius of the plasma stream. (UK)

14276 EFFECT OF BEAM-LIKE ELECTRONS ON DOUBLE PROBE. Ariga, Seiichi (Kyoto Univ., Uji City, Japan). J. Phys. Soc. Jap.; 32: No. 1, 244-8(Jan 1972).

The properties of a double probe in a plasma with an electron beam are theoretically investigated. The beam whose energy is higher than the floating potential affects the double probe and drastically deforms its characteristic curve. It is clarified that the estimation of the electron temperature of the background plasma from such a deformed curve is still possible. (auth)

14277 TRANSIENT PERFORMANCE OF NEGATIVELY BIASED LANGMUIR PROBES. Shih, C. H.; Levi, E. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 10: No. 1, 104-10(Jan 1972).

Negatively biased Langmuir probes constitute one of the most common tools of gaseous plasma physics and are increasingly often used in time-varying situations. To determine the dynamic behavior of Langmuir probes, analytical expressions are derived for the response of planar and cylindrical sheaths to large amplitude and sudden changes in the biasing potentials. It is found that the speed of response depends on the sign of the charge, this asymmetry being particularly pronounced with planar probes. The analysis also leads to equivalent circuits describing the dynamic response of probes in the collisional, as well as the collisionless regimes. These circuits have direct application in analogue simulation and give valuable assistance to the designer of computerized data processing. They show that the time constants characterizing the probe response can exceed $1/\omega_{pi}$ by one order of magnitude and that, at frequencies below $10^{-2}\omega_{pi}$, a frequency range of great interest for the study of turbulence, the dynamic performance of the probes can be approximated by a succession of quasi-steady states. Expressions are derived that relate the mean and the variance of the probe current to the auto and cross correlations of fluctuations in density, temperature, and potential. Particular attention is given to the two cases in which (a) the density fluctuation is overriding and attains large amplitude, a likely occurrence with slightly ionized gases, and (b) the level of fluctuations is low, but more than one type is simultaneously present. Finally, the theoretical findings are examined in the light of experimental evidence reported in the published literature. Although qualitative agreement is good, the simplicity of the analytical model and the inadequate characterization of the experimental conditions often limit the quantitative agreement to one order of magnitude. (auth)

14278 METHOD FOR MEASURING DOPPLER SHIFTS IN ARC-HEATED FLOWS. Aeschliman, D. P.; Hill, R. A. (Sandia Labs., Albuquerque, N. Mex.). Appl. Opt.; 11: No. 1, 148-52 (Jan 1972).

A novel method of determining both the Doppler and Stark shifts in a single measurement of spectral lines emitted by the arc-heated flow from a plasma jet was successfully demonstrated. The method uses a spherical mirror arranged with its optical axis coincident with the optical axis of a Fabry–Perot interferometer and with its center of curvature at the center line of the flow. The common optical axis lies at an angle to the flow. With this system, both red- and blue-shifted line profiles are recorded in the same spectral scan. If conditions are such that the red- and blue-shifted profiles are not resolvable, the blue-shifted component is chopped so that the recorded signal consists of the envelopes of both the red-shifted profile and the superimposed red- and blue-shifted profiles. The wavelength difference between the blue- and red-shifted line profiles is exactly twice the Doppler shift integrated along a line of sight through the flow and is independent of a Stark shift. The Stark shift is given by the wavelength difference between the absolute line center and the midpoint of the red- and blue-shifted lines. Abel inversion of integrated line-shift data yielded radial velocity profiles to an accuracy of ±3% in a supersonic, arc-heated argon flow. (auth)

14279 ELECTROSTATIC PROBE TECHNIQUE FOR DETERMINING THE EFFECTIVENESS OF PLASMA ALLEVIANTS. Luzzi, T.; Jenkins, R. (Grumman Aerospace Corp., Bethpage, N. Y.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 12, 2411-16(Dec 1971).

A theory is derived for a new electrostatic probe technique for determining the depletion of electrons in a plasma due to the introduction of an electron-attaching gas. The technique

makes use of the positive ion saturation currents and the difference of floating potential. No negative-species saturation current measurement is made. The technique is implemented in such a way that all complicated chemical kinetics associated with the electron-attaching gas and plasma are avoided. The utility of the technique was demonstrated in an arcjet experiment in which a readily measurable change in probe floating potential was observed, an indication that the local electron density had been significantly reduced by electron attachment to form negative ions. The arcjet was found to provide a satisfactory flow field for investigation of the effectiveness of various electrophilic gases. (auth)

14280 DETERMINATION OF THE COLLISION PARAMETERS BY MEANS OF LANGMUIR PROBES. Shih, C. H.; Levi, E. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 12, 2417-21(Dec 1971).

The current collected by Langmuir probes in the ion saturation regime is affected by collisions among ions and with neutrals. This effect depends not only on the Debye length and the various mean free paths involved, but also on the geometry, size, and biasing potential of the probes. Two or more independent measurements thus afford means for determining the collision parameters and related quantities such as the ion temperature, the chemical composition of the plasma, and the density of the background gas. Good agreement is obtained between theory and experimental data taken in quite distinct physical situations, by using a hypersonic shock tunnel and a laser discharge. The method presented here could be applied to the determination of ion–neutral collision cross sections in the transition region between the D and E layers of the ionosphere. (auth)

14281 IMMERSION-TYPE ELECTRICAL CONDUCTIVITY PROBE FOR ANISOTROPIC PLASMAS. Stubbe, Elie J. (National Research Council, Ottawa). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 10: No. 1, 92-8(Jan 1972).

From a numerical solution of the Maxwell equations, the impedance variation of a miniature coil is predicted for an anisotropic plasma. Such a plasma is created behind the reflected shock in an expansion-driven 1½-in.-diam shock tube by applying a uniform, quasi-steady axial magnetic field to obtain Hall coefficients of the order of 2. Tensor conductivities and Hall coefficient of the plasma are calculated through an adaptation of Shkarofsky's plasma kinetic theory and are used as a basis for comparison with experiments. An optimized parallel-T bridge, followed by two phase-sensitive detectors, channeling the information from both resistive and reactive change of the coil impedance, proved instrumental in achieving good decoupling and adequate sensitivity. The device exhibits very good time and space resolution and does not require any known electrical conductivity standards for calibrating purposes. The generally good agreement between predicted and observed probe response demonstrates the usefulness of such a diagnostic tool for many important applications involving Hall effect and electrical plasma conductivity. (auth)

Kinetics (General)

14282 (CEA-R-4149) ACCELERATION OF A GASEOUS PLASMA BY INTENSE MICROWAVE FIELDS IN A CONSTANT INHOMOGENEOUS MAGNETIC FIELD. Mourier, Georges (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1971. 155p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, Orsay, France.

A gaseous plasma excited by a powerful microwave source (up to 300 kW) was studied theoretically and experimentally. The large-amplitude electric field excites, in a constant inhomogeneous magnetic field, a plasma near electron cyclotron resonance. These particles are accelerated to energies of between 100 and 10,000 eV and subsequently drift to the regions of lower magnetic field. The ions are accelerated by the resulting electrostatic forces. Ion and electron currents of some tens of milliamperes to a few amperes are obtained. The energy of the electrons is limited by their relativistic mass; a three-dimensional space-charge model is set up to describe the particle flow. (auth)

14283 IONIZATIONAL AND ELECTRON THERMAL NONEQUILIBRIUM IN MHD BOUNDARY LAYERS. Cott, Donald W. (North Carolina State Univ., Raleigh). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 12, 2404-10(Dec 1971).

The effects of thermal nonequilibrium (elevated electron temperatures), and ionizational nonequilibrium (finite-rate recombination) are studied in the insulator layer of a potassium-seeded nitrogen MHD accelerator. The nonsimilar, compressible boundary layer is assumed steady, laminar, and two-dimensional. A collisionless sheath is assumed and matched with the continuum boundary-layer equations through a transition region, the physics of which is dominated by ambipolar diffusion. Numerical results are presented for a typical core-flow Hall-neutralized Faraday accelerator. Profiles are presented, demonstrating the gradual development of severe B-wall shorting with the best available values of energy-loss factor and recombination rate coefficient. The relative importance of the various terms in the electron energy equation is assessed, and the need for more accurate energy-exchange cross sections is pointed out by the high sensitivity of the solutions to energy-loss factor. An unexpected result is that finite-rate recombination is not particularly important for the class of accelerators under study, although it could well be important for other applications, such as noble-gas generators. (auth)

14284 TURBULENT MHD BOUNDARY LAYERS WITH ELECTRON THERMAL NONEQUILIBRIUM AND FINITE RATE IONIZATION. High, M. D.; Felderman, E. J. AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 10: No. 1, 98-103(Jan 1972).

The compressible, turbulent boundary-layer equations representing the flow on the B wall of an MHD accelerator are solved numerically by an implicit finite-difference scheme. The equations solved include the over-all energy, electron conservation, and electron energy; the effects of electron diffusion, electron–thermal nonequilibrium, and finite ionization rates are included. A simplified Ohm's law is used that neglects ion slip. Boundary-layer characteristics are given for the cases of; (1) flat plate at the same free-stream conditions as the accelerator, $\sigma = 0$, (2) constant conductivity evaluated at the free-stream gas temperature, $\sigma = \sigma(T_{g\infty})$, (3) equilibrium electrical conductivity evaluated at the gas temperature, $\sigma = \sigma(T_g)$, (4) equilibrium ionization at the electron temperature, $\sigma = \sigma(T_e)$, (5) frozen ionization with $\sigma = \sigma(n_e, T_e)$, and (6) finite rate ionization, $\sigma = \sigma(n_e, T_e)$. For the last case, no significant amount of ionization nonequilibrium is observed in the boundary layer except very near the wall in the Couette-flow region. A small amount of electron thermal nonequilibrium exists which, because of the strong dependence of the electrical conductivity on electron temperature, causes significant differences from the calculations using thermal equilibrium. It is also shown that the inclusion of the Hall current changes the boundary-layer characteristics substantially. (auth)

14285 CROSS-FLOW BLOWING OF A TWO-DIMENSIONAL STATIONARY ARC. Bose, T. K. (Jet Propulsion Lab., Pasadena, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 10: No. 1, 80-6(Jan 1972).

The effect of cross-flow blowing on a two-dimensional stationary arc between a pair of electrodes is studied theoretically. It is demonstrated in the analysis that the electrons emitted from the cathode undergo collisions with the heavy particles and are deflected in the flow direction by the component of a collisional force associated with the relative difference in flow velocities between electrons and heavy particles. The resultant motion of the electrons describing the arc is thus caused by a combined action of the collisional force that results from the externally applied electric field. An expression is given that enables computation of the arc shape to be made, provided the velocity distribution of the cross flow and the distribution of the externally applied electric field are prescribed. The analysis is applied for a case in which an analytical expression for the distribution of the externally applied electric field is available. An electrical discharge between two point electrodes was chosen with a uniform velocity distribution of the cross-flow. Numerical results are presented for the maximum deflection as a function of a blowing parameter. In addition, it is shown that the temperature distribution within the arc is asymmetric. (auth)

14286 LEVEL SHIFT AND NEGATIVE ION DESTRUCTION IN A PLASMA. Kobzev, G. A. (Inst. of High Temperatures, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 2, 582-92(Aug 1971). (In Russian).

The effect of ambient charged particles on negative ions in a plasma is investigated. The energy level shift of a negative ion in a plasma and effects due to reduction of the negative ion potential barrier induced by microfields of the nearest charged particles are considered. The level shift is studied by quantum field theory methods. The mass and vertex operator diagrams are analyzed. An expression derived for the shift is negative and leads to growth of the coupling energy. The behavior of negative ions in electric microfields is considered on the basis of model concepts. A correction for the ion concentration that takes into account destruction due to microfields is obtained. Estimations for realistic experimental conditions are made. It is shown that recent experiments on nitrogen and air plasma radiation can

be explained if allowance is made for destruction. The result for the shift of the photodetachment threshold of J^-, determined by the energy level shift and the decrease of the potential barrier, agrees with the experimental data. (auth)

14287 PHYSICS OF HIGH-ENERGY DENSITY. Proceedings of the International School of Physics, Enrico Fermi, Varenna, Italy, 14th–26th July 1969. Course XLVIII. Caldirola, P.; Knoepfel, H. (eds.). New York; Academic Press Inc. (1971). 435p. $23.00.

Separate abstracts were prepared for eight of the included sections. (M.O.W.)

For abstracts of individual sections see: 12912, 13468, 14314–14317, 14331, and 14352.

14288 EFFECT OF THE DETECTING SOLID ANGLE ON THE ELECTRON CYCLOTRON RESONANCES OBSERVED IN THE SCATTERING CROSS SECTION OF A LIGHT WAVE BY A PLASMA. Meyer, R. L.; Leclert, G. (Univ., Nancy). Compt. Rend., Ser. B; 273: No. 17, 760-2(27 Oct 1971). (In French).

The scattering cross section of a light wave, modulated by a harmonic of the electron gyrofrequency, by a plasma in a magnetic field is numerically integrated over a solid angle. A comparison of the results with that obtained in the absence of a magnetic field enables the axis of the solid angle and the aperture used for determining the electron cyclotron resonances to be determined. (France)

14289 EXPERIMENTAL PLASMA TURBULENCE. McLane, C. K. (Univ. of Colorado, Boulder). Advan. Electron. Electron Phys.; 30: 1-41(1971).

The following topics are discussed: (1) diffusion, (2) positive column instability and turbulence, (3) drift waves and transition to turbulence, (4) feedback suppression of low-frequency plasma instabilities, (5) convection cells, and (6) other turbulent studies. (M.O.W.)

Kinetics (Experimental)

14290 RATIO OF LONGITUDINAL AND TRANSVERSE DIFFUSION COEFFICIENTS IN A MICROWAVE DISCHARGE IN ARGON. Budnikov, V. N.; Novik, K. M.; Obukhov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 899-901(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1138-40(Jun 1971).

The ratio of the longitudinal diffusion coefficient to the transverse diffusion coefficient $D_{||}/D_{\perp}$ is found in an argon plasma by analyzing the longitudinal distribution of the charged-particle density beyond the region of the microwave discharge. The experimental conditions are as follows: longitudinal magnetic field ~3000 Oe, length of discharge tube 70 cm, diameter 2.5 cm, charged-particle density 10^{12} to 10^{10} cm^{-3}, $T_e \sim 2$ to 10 eV. For pressures between 3×10^{-2} and 3×10^{-3} mm Hg, the ratio $D_{||}/D_{\perp}$ is constant and equal to 25. (auth)

14291 ION CHARGE STATES IN A BEAM–PLASMA SYSTEM. Vladimirov, A. I.; Vorob'ev, E. D.; Saenko, V. A.; Tret'yakov, Yu. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 902-5(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1141-5(Jun 1971).

Ion charge states are investigated for a beam–plasma system in a strong magnetic field. The highest content of multiply charged ions (MCI) is observed in the high-temperature mode. A method for the generation of MCI using a beam–plasma discharge as an ion source is proposed. (auth)

14292 STUDY OF THE EMISSION LINE PROFILES OF A STABILIZED ARC PLASMA HAVING A CYLINDRICAL SYMMETRY. Queffelec, J. L.; Girault, M. (Univ., Rennes, France). Rev. Phys. Appl.; 6: No. 3, 401-7(Sep 1971). (In French).

Two arc plasma sources, S_1 and S_2, stabilized at atmospheric pressure, in Ar and an Ar–H_2 mixture, are described. The plasma possesses cylindrical symmetry. The axial temperature of S_2 is constant within 1%. The photoelectric spectrometry techniques developed enabled line broadening, shifts, and profiles to be studied as a function of temperature, the plasma being observed transversely or longitudinally. (France)

14293 RESONANCES IN THE MICROWAVE EMISSION FROM A BOUNDED MAGNETOPLASMA WITH $\omega p/\omega > 1$ AND $\omega c/\omega > 1$. Tetenbaum, S. J. (Lockheed Palo Alto Research Lab., Calif.). J. Phys. Soc. Jap.; 32: No. 1, 249-55(Jan 1972).

The X-band far-field emission from rf-excited helium, neon, and argon rectangular and cylindrical magnetoplasmas was experimentally investigated in the parameter range in which both $\omega p/\omega$ and $\omega c/\omega$ exceed one. Sharp resonances were found that generally broaden and increase in amplitude and separation as the magnetic field increases. Some peaks had Q's greater than 300. The peaks were maximized by using as high electron energy and as low pressure as possible. The magnetic field positions of the peaks changed very little with pressure and electron energy. As suggested by Kubo, the major features of these peaks can be explained in terms of the formation of standing waves at an angle to the applied magnetic field with their propagation vectors, k, quantized by the dimensions of the plasma. Two series of peaks were observed, one corresponding to emission into free space of an ordinary wave ($E \parallel B$; $k \perp B$), and the other to emission of an extraordinary wave ($E \perp B$; $k \perp B$). (auth)

14294 RADIAL MODE DISTRIBUTION IN A BEAM–PLASMA SYSTEM. Sakharov, I. E.; Fedorov, V. I. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1206-8(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1536-9(Jul 1971).

The spatial distribution of the modes excited by an electron beam in a finite anisotropic plasma is measured with a movable microwave probe. The dispersion characteristics of the highly retarded electromagnetic waves and electrostatic plasma waves are compared with the experimental results. Under the conditions of the experiment the excitation of slow electromagnetic waves is the predominant feature. (auth)

Kinetics (Theroretical)

14295 (LA-4782) NUMERICAL CALCULATION OF THE THETA, Z, AND SCREW PINCHES. Haberstitch, Albert (Los Alamos Scientific Lab., N. Mex.). Dec 1971. Contract W-7405-eng-36. 23p. Dep. NTIS.

A one-dimensional MHD program for the computation of cylindrical theta, z, and screw pinches is formulated. The derivation is essentially a continuation of the theta pinch calculation of Oliphant. The theta pinch is assumed to be driven by a current of known magnitude, while the z pinch is driven either by a known current or by an external LC circuit. The calculations make use of the equations of motion and continuity, the generalized Ohm's law, separate energy equations for the ions and electrons, and Maxwell's equations. Included are the ion and electron heat conductivities, the equipartition time, the Richtmyer–Von Neumann artificial viscosity, an electrical resistivity tensor, and an optional thermoelectric effect. The case of a biased z pinch with both classical and anomalous resistivity is examined. (auth)

14296 (UCB-34-P-128-X-1) AEC PORTION OF THE PLASMA SEMIANNUAL PROGRESS REPORT, 1 JANUARY THROUGH 30 JUNE 1971. (California Univ., Berkeley). Contract AT(04-3)-34. 48p. Dep. NTIS.

An impurity mixing experiment to observe the effects and to try to verify the theory for the impurity mixing instability is described. Changes in the apparatus during this period, along with probe characteristics and experimental measurements of density, noise, and oscillation, are reported. Further research work on computer simulation of plasma heating processes is described. The meaning attached to the beam–plasma parameter $PE_{beam}/KE_{plasma} \equiv S$ is investigated. Computer simulations of ion heating by rf modulated electron beams are analyzed. Finally, properties of simulation plasmas are discussed. (M.O.W.)

14297 INTERACTION OF ADJACENT HOT PLASMA STREAMS. I. DIELECTRIC PERMEABILITY TENSOR COMPONENTS. El-Siragy, N. M.; Pakhomov, V. I.; Zayed, K. E. (Atomic Energy Establishment, Cairo). Plasma Phys.; 13: No. 10, 913-18(Oct 1971).

The expressions for the components of the dielectric permeability tensor of a relativistic plasma stream are obtained. The parameters (density, longitudinal temperature, and equilibrium velocity) of the plasma stream vary over the cross section of the steam that moves along an external magnetic field. Collisionless damping of surface waves in a semi-infinite isotropic plasma is considered. (auth)

14298 INTERACTION OF ADJACENT HOT PLASMA STREAMS. II. SURFACE WAVE AMPLIFICATION. Hussein, A. M.; Pakhomov, V. I. (Atomic Energy Establishment, Cairo). Plasma Phys.; 13: No. 10, 919-24(Oct 1971).

A dispersion equation describing electromagnetic waves propagating along the plane boundary of adjacent plasma streams was obtained. An external magnetic field is parallel to the unperturbed velocities of the stream and uniform throughout space. Stream velocities may be relativistic. The longitudinal thermal particle motion is taken into consideration. The amplification of surface

waves propagating along the external magnetic field in a half-bounded plasma were investigated. Expressions for amplification coefficients in both the cold stream case and in the case of a stream with large thermal spread of the longitudinal velocities were obtained. (auth)

14299 STRESS TENSOR FOR A FULLY IONISED COLLISIONLESS PLASMA IN TIME-DEPENDENT ELECTRIC FIELD. Midha, J. M.; Gupta, S. C. (Punjabi Univ., Patiala, India). Plasma Phys.; 13: No. 10, 933-7(Oct 1971).

An expression for the viscous stress tensor for a fully ionized collisionless plasma in the presence of a strong magnetic and varying electric fields is derived. It is done by solving the Vlasov equation by Grad's 13-moment approximation. Damping and thermal effects were also considered. (auth)

14300 VORTICITY SUPPRESSION TIME FOR A HALL-EFFECT PLASMA. Witalis, E. A. (Research Inst. of the Swedish National Defence, Stockholm). Plasma Phys.; 13: No. 10, 939-45(Oct 1971).

The deduction by Shercliff (1965) of the vorticity suppression time for an ideal MHD fluid is extended so as to include the effect of Hall conductivity. The decay time for vorticity in the magnetic field direction is found to be increased by up to a factor $1 + \beta^2$, where β is the plasma Hall parameter. A simplified derivation of the same result makes evident the physical reasons for the long suppression time, which is most likely related to experimentally observed long lifetimes of plasma vortex structures like convective cells or plasmoids. The property of a Hall plasma to acquire magnetically induced rotational motion, a form of the Einstein–de Haas effect, is pointed out as an important source of vorticity. (auth)

14301 INFLUENCE OF SYMMETRY ABOUT THE MAGNETIC VECTOR ON THE SPECTRUM OF LIGHT SCATTERED BY A MAGNETIZED PLASMA. Carolan, P. G.; Evans, D. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Plasma Phys.; 13: No. 10, 947-53(Oct 1971).

The spectrum of light scattered by a plasma in a magnetic field is computed with real geometry effects included. When the scattering vector k is almost perpendicular to the magnetic field B, the spectrum consists of a sequence of peaks which are smeared unless $2\ kv_e \sin\phi \leq \omega_{ce}$. Experimentally, scattered light is collected over a cone of k vectors and the spectrum which is observed consists of contributions from all the k's within this cone. A general conclusion is that it is considerably easier in practice to meet the conditions required for the observation of magnetic modulation in a scattered light experiment than had been believed. (UK)

14302 CHARGE-EXCHANGE EFFECTS IN A DISCHARGE IN A STRONG TRANSVERSE MAGNETIC FIELD. Popov, Yu. S.; Zolotaikin, Yu. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 939-43(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1188-95(Jun 1971).

Resonant charge exchange, the structure of the anode sheath, and the characteristics of an electric discharge with a closed Hall current in a strong transverse magnetic field are investigated. The problem is solved numerically on a computer. The particle density distribution, the potential distribution in the sheath, and the characteristics of the ions and fast neutrals are studied as functions of the external parameters. (auth)

14303 INDUCED CURRENTS IN A STATIONARY PLASMA FLOW IN AN AXIALLY SYMMETRIC MAGNETIC FIELD. Cherkasova, K. P.; Azovskii, Yu. S.; Guzhovskii, I. T. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 948-51(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1201-6(Jun 1971).

An analysis based on the magnetohydrodynamic approximation is used to find the polar Hall current in a stationary, weakly interacting, and weakly conducting plasma with a uniform parameter distribution across its cross section. The magnetic field is assumed to be the same inside and outside the plasma. (auth)

14304 CURRENTS IN A PLASMA STREAM IN THE PRESENCE OF THE HALL EFFECT. Cherkasova, K. P.; Kalmykov, A. A.; Tereshin, V. I.; Chebotarev, V. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 952-8(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1207-15(Jun 1971).

The structure of the currents in a steady plasma stream moving through a space-periodic magnetic field is discussed in the magnetohydrodynamic approximation, with the Hall effect taken into account. Solutions are obtained for small magnetic Reynolds number and small interaction parameter. An experimental study of the current structure is reported, and the theoretical and experimental results are compared. (auth)

14305 CORRELATION AND RADIATIVE CORRECTIONS TO THE ENERGY OF A LOW-TEMPERATURE RELATIVISTIC PLASMA. Braun, M. A.; Sibirkina, T. N. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 61: No. 2, 593-603(Aug 1971). (In Russian).

A method is proposed for calculating the ground-state energy of a relativistic plasma at T = 0. The method is based on the determination of the Fermi momentum by means of the electron Green function. The expression for the energy of a relativistic Fermi system is obtained explicitly in a renormalized form. Ultraviolet and infrared divergences are removed. Radiative and correlation corrections to the energy in the lowest order are expressed explicitly in terms of finite integrals. The nonrelativistic limit is considered in detail. (auth)

14306 PLASMA MOTION IN A STRONG, INCREASING DIPOLE MAGNETIC FIELD. Somov, B. V.; Syrovatskii, S. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 2, 621-8(Aug 1971). (In Russian).

A solution of the nonlinear problem of plasma flow in a growing dipole magnetic field is obtained in the strong-field magnetohydrodynamic approximation. The plasma velocity and displacement and density distributions are calculated. It is shown that condensation of the plasma near the dipole axis occurs in a growing dipole magnetic field. Possible applications of the effect are discussed. (auth)

14307 THERMOCHEMICAL NONEQUILIBRIUM IN AN ARGON CONSTRICTED ARC PLASMA. Clark, K. J.; Incropera, F. P. (Purdue Univ., West Lafayette, Ind.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 10: No. 1, 17-18(Jan 1972).

A multifluid model is used to describe the nonequilibrium plasma, and the resulting numerical solutions are compared with both existing experimental data and equilibrium solutions. In addition, a parametric study is performed to determine the spatial extent of the nonequilibrium condition as a function of arc operating variables and the effects of collision cross section and wall-temperature uncertainties on the predictions are ascertained. (auth)

14308 DEPENDENCE OF PLASMA CONDUCTIVITY ON THE ELECTRON-VELOCITY DISTRIBUTION FUNCTION. Zhivlyuk, Yu. N. (Inst. of Spectroscopy, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1065-7(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1353-6(Jul 1971).

General expressions that relate the electron-velocity distribution function to the conductivity of a plasma are given. A simple expression is obtained for the conductivity for the case in which the electron-velocity distribution is a highly displaced Maxwellian $f = C_0 \exp[-m(v - v_d)^2/2kT_e]$. (auth)

14309 PLASMA FLOW IN A STRONG TRANSVERSE MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1096-1101(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1392-9(Jul 1971).

Plasma flow across a strong inhomogeneous transverse magnetic field is investigated. In a strong magnetic field an injected flow is brought to a stop and reflected from the barrier. The resulting polarizing interaction between the injected and reflected flows leads to an instability and plasma trapping in the direction along the lines of force. (auth)

Production

14310 EFFECTS OF HIGH-POWER LASER RADIATION. Ready, John F. New York; Academic Press Inc. (1971). 443p. $17.50.

Lasers offer a new type of high-power light source, capable of producing interesting and useful effects. Effects are interpreted as interactions between high-power laser beams and matter, including heating, melting, vaporization, plasma production, gas breakdown, breakdown of transparent materials, and biological effects. Experimental data are interpreted and detailed information on how to use laser effects in actual industrial applications is reviewed. Production engineers are able to evaluate laser materials processing for specific applications from the information. Properties, measurement techniques, and safety aspects of the lasers themselves are presented. A method for determining laser-induced temperature increases in cases of practical interest is explained. (J.C.W.)

14311 OPTICAL MECHANISM FOR ENHANCED ABSORPTION OF LASER ENERGY INCIDENT ON SOLID TARGETS.

Godwin, R. P. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 28: No. 2, 85-7(10 Jan 1972).

A resonance absorption occuring in the classical optics of thin films for incident light at the plasma frequency is proposed to explain the reflectance and absorptance observed concurrently with neutron production in the heating of deuterium targets with Nd: glass laser pulses. (auth)

14312 COMMENTS ON "DEMONSTRATION OF COLLISIONLESS INTERACTIONS BETWEEN INTERSTREAMING IONS IN A LASER-PRODUCED-PLASMA EXPERIMENT". Wright, T. P. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. Lett.; 28: No. 5, 268-70(31 Jan 1972).

It is shown that the results of a recent laser-produced-plasma interaction experiment by Dean et al., can be explained by collisional processes. (auth)

14313 VACUUM CHAMBER (16 Jul 1968) (Engineering Materials). (Oak Ridge Operations Office (AEC), Tenn. Maryland Univ., College Park). (CAPE-2162).

4 drawings.

A cylindrical vacuum chamber, used to study conditions in laser-produced plasmas streaming in a vacuum 18 to 50 cm from the point at which the laser is focused on a solid target, is fabricated of 304 stainless steel with internally welded seams. A set of gas-supply bottles allows backfilling to pressures of several microns of He, H, Ne, Ar, Kr or Xe. (For details see TID-4100 Suppl 68.) (See also NSA 24: 37433 and 25: 45487.) (F.S.)

14314 HIGH-TEMPERATURE AND PLASMA PHENOMENA INDUCED BY LASER RADIATION. Krokhin, O. N. (Lebedev Inst. of Physics, Moscow). Rend. Scu. Int. Fis. Enrico Fermi; 48: 278-305(1971).

An approximate mathematical description is given for laser radiation interacting with plasma. The evaporation process, the process of plasma formation, and plasma heating are discussed. (M.O.W.)

14315 INTERACTION OF INTENSE PHOTON AND ELECTRON BEAMS WITH PLASMAS. Kidder, R. E. (Univ. of California, Livermore). Rend. Scu. Int. Fis. Enrico Fermi; 48: 306-52(1971).

The following topics are included: (1) properties of laser beams, plasmas, and their interactions, (2) hydrodynamics of laser-produced plasmas, (3) production of multikilovolt tenth-microgram deuterium or mercury plasmas, (4) nonlinear optical effects in plasmas, and (5) plasma heating by an intense burst of relativistic electrons. (M.O.W.)

14316 PLASMA PRODUCED BY SUBNANOSECOND LASER PULSES. Gratton, R. (EURATOM–CNEN, Frascati, Italy). Rend. Scu. Int. Fis. Enrico Fermi; 48: 363-9(1971).

The production of plasma by subnanosecond laser pulses is briefly discussed. An experiment test of a theoretical model is described. Plasma parameters in the experiment are outlined. (M.O.W.)

14317 PRODUCTION OF DENSE THERMONUCLEAR PLASMAS BY INTENSE RELATIVISTIC ELECTRON BEAMS. Winterberg, F. (Univ. of Nevada, Las Vegas). Rend. Scu. Int. Fis. Enrico Fermi; 48: 370-401(1971).

The following topics are included: (1) conditions for the ignition of a small thermonuclear explosion, (2) the interaction of the intense relativistic electron beam with the target, (3) method of bombarding a target by an intense relativistic electron beam from a pulsed field emission discharge, (4) conversion of the energy into useful power, (5) rocket propulsion, and (6) the generation of intense ion beams. (M.O.W.)

Stability

Refer also to abstracts 14267 and 14271.

14318 (JINR–P9-6136) STABILIZATION OF THE KINK INSTABILITY OF THE TWO-COMPONENT RELATIVISTIC RING BY AN AZIMUTHAL MAGNETIC FIELD. Bonch-Osmolovskii, A. G.; Reshetnikova, K. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The kink-instability is considered for the case of an azimuthal magnetic field. It is shown that, at sufficiently high values of the magnetic field, the stability regions are changed. In particular, the instability can be stabilized at significant beam densities. (auth)

14319 INSTABILITY OF FINITE-PRESSURE INHOMOGENEOUS PLASMA IN A LONGITUDINALLY INHOMOGENEOUS MAGNETIC FIELD. Mikhailovskii, A. B. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 13: No. 10, 955-63(Oct 1971).

The "drift" instability of finite-pressure plasma in a longitudinally inhomogeneous magnetic field is theoretically investigated. The calculations take into account the fact that the particles can be trapped in such a field and so move off resonance with the wave. It is shown that, owing to the trapping of the resonant electrons, the growth rate of the "drift" instability decreases. The resonant interaction of the oscillations with ions leading to damping is also included. The number of resonant ions depends on the parameter $\beta \equiv 8\pi p_0/B_0^2$, where p_0 is the plasma pressure and B_0 the magnetic field in the plasma. The critical value of β is calculated, above which the damping by ions exceeds the excitation by electrons. It proves to be smaller than 10%. (auth)

14320 IONIZATION INSTABILITY IN A STRATIFIED PLASMA. Badiali, M.; Zampaglione, V. (CNEN, Frascati, Italy). Plasma Phys.; 13: No. 10, 965-75(Oct 1971).

Ionization instability in a stratified nonequilibrium plasma subjected to crossed E and B fields is investigated by means of a simple model without diffusion processes and boundary effects. An inhomogeneous infinite plasma, consisting of alternate one-dimensional layers of high and low electron temperature ($T_{02} > T_{01}$) lying in the plane perpendicular to the magnetic field is taken as the unperturbed state. It is shown that, in order that a periodic stratified plasma by stable on the whole, some conditions on the thicknesses of the layers must be fulfilled and at least one of the two sets of layers (e.g., that with electron temperature T_{01}) must be intrinsically stable (in the sense that a uniform infinite plasma with electron temperature T_{01} must be stable with respect to the ionization instability). (auth)

14321 PARAMETRIC INSTABILITY OF A MAGNETOPLASMA IN A HIGH-FREQUENCY ELECTRIC FIELD. Andreev, N. E.; Kirii, A. Yu. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 854-9(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1080-7(Jun 1971).

The effect of the constant magnetic field, plasma parameters, and a high-frequency external electric field on the instability limits and growth rate for longitudinal plasma oscillations is studied. Conditions are found under which a significant reduction in the threshold high-frequency field obtains; there is a corresponding increase in the growth rate as compared with no magnetic field. (auth)

14322 PARAMETRIC PLASMA INSTABILITY IN CONSTANT MAGNETIC AND WEAK HIGH-FREQUENCY ELECTRIC FIELDS. Andreev, N. E. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 8, 1160-7(1971). (In Russian).

When the external hf field frequencies are close to the electron plasma oscillations, parametric plasma instability takes place at relatively small values of the external field intensity. Expressions are obtained for the increments and threshold values of hf field intensity when the oscillations are excited with the frequencies exceeding the ion gyroscopic frequency. (auth)

14323 EFFECT OF COLD PLASMAS ON THE DIOCOTRON MODES. d'Ambrogio, E. (Univ., Trieste, Italy). Acta Phys. Austr.; 32: No. 3-4, 282-9(Mar 1970). (In German).

A cylindrical layer of charged particles in crossed electric and magnetic fields is considered, when a cold neutral plasma is present. The conditions of stability against electrostatic flute-like perturbations show that the diocotron modes can be affected even though the plasma density is very small with respect to the beam density. Two examples are examined to show that the plasm behavior (stabilizing or destabilizing) is strongly affected by the presence of conducting walls. A condition is then obtained for the jumps of the zero-order electric field at the boundaries of the beam, under which the cold plasma is stabilizing. (auth)

14324 NONLINEAR EFFECTS IN THE TWO-STREAM INSTABILITY. Fedorchenko, V. D.; Muratov, V. I.; Rutkevich, B. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1091-5(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1386-91(Jul 1971).

The nonlinear stabilization of the two-stream instability is studied under conditions such that the phase velocity of the wave in the beam–plasma system is approximately equal to the beam velocity, so that beam electrons can be trapped by the wave. The development of this process is complicated by decay phenomena which depend significantly on the external magnetic field. Rapidly damped low-frequency oscillations are excited under certain

conditions as the result of the decay of space-charge waves. Heating of the electron component of the plasma is also observed. (auth)

14325 ACOUSTIC INSTABILITIES IN A WEAKLY TURBULENT PLASMA. Makhan'kov, V. G.; Shchinov, B. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 1043-4(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1326-8(Jun 1971).

The summation of the series obtained by expanding the energy of the high-frequency oscillations was carried out, and it is shown that the range of applicability of the results obtained earlier by the author is substantially wider than had been assumed. (auth)

14326 INTERNAL FEEDBACK IN A PLASMA AND CONTROL OF INSTABILITIES BY AN EXTERNAL FEEDBACK. Tsukishima, Takashige; Mase, Atsushi (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 32: No. 1, 256-9(Jan 1972).

An internal feedback mechanism responsible for the natural excitation of instabilities in a plasma and its diagrammatical representation similar to that for the conventional feedback amplifier are proposed. A theory is also developed where the internal feedback is linked with an external feedback loop to obtain a unified account for the feedback control of the instabilities. (auth)

14327 CROSS-FIELD ION-ACOUSTIC INSTABILITY OBSERVED IN A TURBULENT-HEATING EXPERIMENT. Hirose, A.; Lonngren, K. E.; Skarsgard, H. M. (Univ. of Saskatchewan, Saskatoon). Phys. Rev. Lett.; 28: No. 5, 270-3 (31 Jan 1972).

A high-frequency ($\omega_{ci} \ll \omega \simeq \omega_{pi}$) electrostatic instability observed in a toroidal turbulent-heating device was interpreted in terms of ion-acoustic waves excited by a radial, electron temperature gradient across a toroidal magnetic field. The waves were found to propagate across the field, in the direction opposite to the electron diamagnetic velocity. Observed anomalous electron thermal transport was explained by the instability. (auth)

14328 ACOUSTIC INSTABILITY IN A NONISOTHERMAL PLASMA. Nemchinskii, V. A. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1077-80(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1369-73(Jul 1971).

The acoustic instability is analyzed in an electron plasma whose temperature is raised by Joule heating. Since an appreciable departure of the electron temperature from the neutral temperature occurs at the critical current for the acoustic instability ($i \sim en_e v_s$), the nonisothermal nature of the plasma is of great importance in the instability criterion. In particular, Hall parameter and the electron temperature can be chosen so that the instability is only excited at very high currents. (auth)

14329 INSTABILITY IN A MAGNETIZED AFTERGLOW. Bulanin, V. V.; Zhilinskii, A. P. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1081-6(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1374-81(Jul 1971).

The fluctuations of the potential in a weakly ionized afterglow are investigated using electrostatic probes. The plasma is located in a dielectric chamber 1.2 cm in diameter in a homogeneous magnetic field of 5000 Oe. The correlation functions of the oscillations are obtained. The nature of the space–time correlation functions and the power spectra indicates that a drift type instability develops. The plasma is in a turbulent state; the potential and density perturbations are correlated along the magnetic field but only weakly correlated in the transverse direction. The turbulent diffusion coefficient is estimated from the statistical characteristics of the fluctuations. The value is compared with the value of the diffusion coefficient obtained from the change in mean plasma density with time in the afterglow. (auth)

Thermonuclear Processes

Refer also to abstracts 13356, 14311, and 14317.

14330 (LA–4828) PARAMETER STUDY OF A LONG, SEPARATED-SHOCK Θ PINCH WITH SUPERCONDUCTING INDUCTIVE-ENERGY STORAGE. Ribe, F. L. (Los Alamos Scientific Lab., N. Mex.). Dec 1971. Contract W-7405-eng-36. 14p. Dep. NTIS.

Present Θ-pinch experiments involve high-β plasmas with area compression ratios of the order of 40, using high-voltage capacitors to provide both the early shock heating (during the first few tenths μsec) and the later adiabatic compression, in a single-turn coil. In the separated-shock concept, the shock heating is done by high-voltage circuits whose energy content is only a few percent of that of the total system. The compression magnetic energy, which is preponderant, is contained in a multiturn coil with slow rise time (of the order of milliseconds) appropriate to adiabatic compression of the plasma in long systems. The area compression ratios are less than 10. Physical parameters and costs of a large system, appropriate to a scientific feasibility experiment at $kT_i \approx 10$ keV and $n\tau \approx 10^{14}$ cm^{-3} sec are derived. The shock heating is calculated on the basis of plasma sheaths driven by Blumlein transmission lines, although other electrical circuits might be used. The adiabatic compression field is assumed to be energized by a superconducting inductive energy source, switched by normal-going superconductors. (auth)

14331 CUMULATION OF ELECTROMAGNETIC ENERGY. Knoepfel, H. (EURATOM–CNEN, Frascati, Italy). Rend. Scu. Int. Fis. Enrico Fermi; 48: 168-88(1971).

The principle of cylindrical flux compression is discussed. The limitations of the principle are analyzed by taking the electric conductivity and the compressibility into account. The instabilities of the conductor surface and the explosively driven generator are discussed in particular. (M.O.W.)

14332 STRUCTURE OF THE MAGNETIC FIELD OF THE STELLARATOR–TORSATRON SATURN-1. Voitsenya, V. S.; Georgievskii, A. V.; Ziser, V. E.; (and others). At. Energ. (USSR); 31: No. 5, 536-8(Nov 1971). (In Russian).

The stellarator–torsatron "Saturn-1" was designed for investigating the properties of magnetic fields generated by coils of various types and for testing these fields for plasma confinement. The intensity of the longitudinal magnetic field under quasi-stationary conditions is about 6 kOe, and over 10 kOe when pulsed. The toroidal radius = 35.6 cm, with a small radius of 10 cm, and the number of periods of the field = 8. The behavior of the system is described for the two types of functional operation: as a stellarator and as a torsatron. (K.S.W.)

14333 INVESTIGATION OF PLASMA NEUTRON RADIATION FROM THE TOKAMAK T-3A INSTALLATION. Artsimovich, L. A.; Anashin, A. M.; Gorbunov, E. P.; (and others). Zh. Eksp. Teor. Fiz.; 61: No. 2, 575-81(Aug 1971). (In Russian).

Prolonged, easily reproducible neutron radiation is recorded in the Tokamak T-3A installation at a deuteron temperature exceeding 300 eV and plasma concentration of (4 to 6) × 10^{13} cm^{-3}. The deuteron temperature, determined on basis of the absolute intensity of the neutron radiation, is identical to that obtained by analyzing the charge-exchange atomic beam from the plasma. Results of the experiments indicate that the neutron radiation is of a thermonuclear nature; this is in accordance with the assumption of a Coulomb heating mechanism of most of the plasma ions in Tokamak T-3A. (auth)

14334 OUTLOOK FOR CONTROLLED FUSION POWER WITH NOTES ON ITS RELATION TO HELIUM CONSUMPTION. Tuck, J. L. (Los Alamos Scientific Lab., N. Mex.). pp 212-52 of Helium Society. /Blizin, Jerald (comp.). Washington, D. C.; Helium Society (1971).

From Helium society symposium; Washington, D. C. (3 May 1971).

Fission and fusion are compared as a source of energy for the future. Energy reserves for the two are similar, as are their pollution and ecological characteristics. A remote integrated site policy is recommended for fission. Schematic diagrams of future fusion reactors with scales are given, and the status and problems of the four most likely fusion power contenders are discussed. Takeover of fusion from fission is estimated to begin in 2000 A.D. Fusion as a future producer of helium is not an important source, even when compared with present consumption, but may be a major user of helium (future inventory comparable with present world reserves), indicating that a world-wide shortage of helium will develop unless stringent conservation is imposed without delay. Taxation is proposed as a means of restricting wastage and financing conservation. (auth)

14335 ANODE PHENOMENA IN HIGH-CURRENT ACCELERATORS. Oberth, Ronald C.; Jahn, Robert G. (Princeton Univ., N. J.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 10: No. 1, 86-91(Jan 1972).

Experimental study of various anode processes in quasi-steady magnetoplasmadynamic accelerators has clarified certain aspects of the current conduction and power loss mechanisms in these devices. Measurements of local anode-fall voltage and anode current density in argon arcs operated at currents of 8.7, 17.5, and 42.0 kA indicate an inverse relationship between these two quantities which translates into a significant decrease in fractional anode power loss for operation in the megawatt range of pulse power. For matched and overfed mass flows, anode current

conduction appears to be accomplished by random thermal flux of electrons from the adjacent arc plasma. For underfed conditions, substantial electric fields develop around the anode to enhance anode current conduction from the lower plasma-density environment. Approximate calculations indicate that these fields accomplish this by a combination of tensor electron conduction and ionization through local resistive heating. (auth)

14336 APPLICATIONS OF CRYOGENICS IN PLASMA PHYSICS. Grieger, G. (Institut fuer Plasmaphysik, Garching, Ger.). pp 447-9 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The important role played by cryogenics in high-energy plasma physics is discussed, especially with regard to the development of a fusion reactor. Examples are also given of the cryogenic aspects of multipoles and a stellarator. (auth)

14337 NUMERICAL CALCULATION OF A TOKAMAK MAGNETIC FIELD. Bazhanova, A. E.; Shafranov, V. D. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1068-72(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1357-63(Jul 1971).

The magnetic field distribution which confines an axisymmetric toroidal plasma with radii α and R in equilibrium is calculated in the magnetohydrodynamic approximation. The calculations hold for the distribution of the longitudinal current $j_\varphi = Ar + B/r$, where A and B are constants that describe the plasma pressure and the plasma diamagnetism with respect to the longitudinal magnetic field. The following results are obtained. It is shown that the confining magnetic field is almost uniform even for a highly curved plasma torus with $R/\alpha = 1.5$. The limiting value of the parameter β_j (the ratio of the plasma pressure to the magnetic pressure of the longitudinal current J) compatible with confinement is calculated. The dependence of the mean well depth and rotational transform on the plasma pressure is calculated, and it is shown that the shear increases significantly near the critical pressure. The distribution of the surface current producing the confining magnetic field necessary for equilibrium and the current distribution in a superconducting torus are calculated. The confining field produced by currents in specified conductors is presented. (auth)

Wave Phenomena

14338 (CONF-710921-2) COMPUTATIONAL STUDY OF SHOCK WAVES. Chu, C. K. (Columbia Univ., New York). 1971. Contract AT(30-1)-3954. 24p. Dep. NTIS.

From International symposium on dynamics of ionized gases; Tokyo, Japan (13 Sep 1971).

A direct numerical analysis of the Vlasov equation was used to study the formation of ion acoustic collisionless shocks. A time-dependent study was made of the formation and structure of one-dimensional collisional shock waves, in which all physical transport properties are included. A preliminary report is given on the reflection and focusing of hydromagnetic shock waves from a curved wall. (M.O.W.)

14339 (JUL-781-PP) ELECTROSTATIC OSCILLATIONS IN AN INHOMOGENEOUS PLASMA. Hirsch, R. H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Aug 1971. 40p. Dep. NTIS (U. S. Sales Only).

A numerical solution of the nonlinear Vlasov equation in one dimension is carried out by the Fourier-Fourier transformation method for the case of an inhomogeneous plasma. The initial electron distribution function consists of a background Maxwellian plasma plus two Maxwellian bumps at $\pm v_b$, which appear only in the central region of the plasma. The magnitude of the bumps is linear functions of x within this central region, having a maximum strength D at the center. The ions are assumed immobile and are chosen so that, at t = 0, the plasma is neutral. Perfectly reflecting walls are used as boundary conditions at x = 0 and L. The linear equation is also solved numerically and compared with the linear solution obtained by the method of Landau poles. The macroscopic variables of density N (x,t) average velocity $\bar{V}$ (x,t) and pressure P (x,t) are recovered at specified time intervals. The microscopic movement of particles is also followed and plotted as the difference between the initial and $t = t_0$ distribution functions. (auth)

14340 CONVERSION OF WAVES IN A BEAM-PLASMA SYSTEM INTO ELECTROMAGNETIC RADIATION. Sakharov, I. E.; Fedorov, V. I. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1209-12(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1539-43(Jul 1971).

The relative efficiency of the conversion into electromagnetic radiation of the oscillations excited by an electron beam in a bounded anisotropic plasma (produced independently of the beam) is studied. The range of variation of the magnetic field and the density are $(\omega_0/\omega)^2 < 2$ and $0.1 < \omega_H/\omega < 1.5$. Conversion is most effective when the upper hybrid resonance condition is satisfied. (auth)

14341 NONLINEAR THEORY OF LONGITUDINAL OSCILLATIONS OF INHOMOGENEOUS ISOTROPIC PLASMA. Demchenko, V. V.; El-Naggar, I. A. (Atomic Energy Establishment, Cairo). Plasma Phys.: 13: No. 10, 887-96(Oct 1971).

Nonlinear longitudinal oscillations produced by applied high-frequency fields in a cold nonhomogeneous plasma are investigated. Within a certain range of applied frequencies, the plasma is shown to develop a parametric-type resonance. Unlike a homogeneous plasma where the parametric excitation of the oscillations occurs at a harmonic of the applied frequency, inhomogeneous plasma is shown to develop the parametric resonance at its subharmonics. The nonlinear components governed by the density nonuniformity in the equations of motion are shown to restrict the amplitude growth in the resonance region. (auth)

14342 POSSIBILITY OF HIGH-FREQUENCY FIELD PENETRATION INTO A NONTRANSPARENT PLASMA. Demchenko, V. V.; Hussein, A. M. (Atomic Energy Establishment, Cairo). Plasma Phys.; 13: No. 10, 996-8(Oct 1971).

Physical interpretation of a high-frequency field penetration into the region of plasma "non-transparency" is offered. (UK)

14343 PROPAGATION OF A STRONG CIRCULARLY POLARIZED ELECTROMAGNETIC WAVE THROUGH AFTERGLOW PLASMAS NEAR THE ELECTRON CYCLOTRON FREQUENCY. Shkarofsky, I. P. (Radio Corporation of America Ltd., Montreal). Can. J. Phys.; 49: No. 22, 2797-2824(15 Nov 1971).

The experimental observation of enhanced transmission of a strong right-hand circular wave near cyclotron resonance in an afterglow helium slab plasma occurring at earlier times than for a corresponding weak electromagnetic field is considered. A strong field heats the electrons and alters the collision frequency and the velocity distribution function. Under the experimental conditions, electron-electron relaxation process can influence the distribution function. Furthermore, because of the field dependent absorption coefficient, the temperature and field strength can vary within the plasma slab. Although the collision frequency increase with temperature predicts an earlier time for stronger-field transmission at cyclotron resonance, none of the above processes is sufficient to explain the experimentally observed large spread in times of transmission for various electric field strengths. The explanation is ascribed to the fact that the electron density decay constant due to diffusion also increases with temperature, so that the electron density decay rates vary with electric field resulting in a larger spread in times of transmission. Experimental results from double probes, although operating under low sensitivity, suggest a decrease near the front edge of the plasma subject to strong fields. (auth)

14344 ABSORPTION OF A PLANE ELECTROMAGNETIC WAVE IN A CIRCULAR PLASMA CYLINDER. Bogomolov, Yu. V. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 8, 1168-75(1971). (In Russian).

The section of absorption of a plane electromagnetic wave in a circular plasma cylinder in a constant magnetic field parallel to the cylinder axis is calculated. The cases are investigated of the normal incidence of a wave with the electric vector polarized along and across the cylinder axis. In the latter case, the displacement current is neglected. At the plasma boundary the electron scattering is assumed diffusive. Calculation is made under the assumption that the mean electron Larmor radius is much smaller than the cylinder radius and the wavelength. (auth)

14345 NONLINEAR ION SOUND WAVES IN AN INHOMOGENEOUS WEAKLY-ABSORBING PLASMA. Pelinovskii, E. N. (Scientific-Research Inst. of Radiophysics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 8, 1281-3(1971). (In Russian).

A nonlinear ion sound wave may propagate itself in a strongly nonisothermal plasma described by the Korteweg-de Vries equations. A particular class of such waves are solitons, which play an important role in the theory of nonstationary decay processes. Here, wave processes were investigated in a inhomogeneous, weakly absorbing plasma. A general equation is developed that can be solved only for particular cases, of which two are examined: transformation of a wave in a nonhomogeneous plasma, and the propagation of a soliton in a heterogeneous weakly absorbing plasma. (K.S.W.)

14346 STUDY OF WAVES AT A PLASMA/VACUUM BOUNDARY. Boulanger, P.; Ashby, N. (Univ. of Colorado, Boulder). Helv. Phys. Acta; 44: No. 6, 737-56(1 Oct 1971).

Using the specular reflection condition for electrons at the boundary, the dispersion relation for surface waves is calculated. The disappearance of the so-called surface plasmon effect is shown when proper boundary conditions are taken. Generation of transverse waves by longitudinal waves striking the plasma/vacuum transition and longitudinal waves created by an impinging electromagnetic wave are discussed. (auth)

14347 EFFECT OF THE HALL FIELD ON THE INTERACTION OF MAGNETOHYDRODYNAMIC WAVES IN AN INHOMOGENEOUS PLASMA. MAGNETOHYDRODYNAMICS. Grebinskii, A. S. (Leningrad State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 915-18(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1159-63(Jun 1971).

Dispersion curves were obtained for magnetohydrodynamic (MHD) waves in an inhomogeneous plasma, with the Hall effect taken into account. The character of the dispersion curves depends strongly on the role of the Hall field; for $\gamma \ll \beta$ ($\gamma \equiv \vartheta^2$) there are coupled triple-branch dispersion curves in the region $V_s \approx V_a$ for $a = \pm\sqrt{\beta}$($a \equiv V_s^2/V_a^2 - 1$, $\beta \equiv \omega^2/\omega_i^2$; ϑ is the angle between the wave propagation vector and the external magnetic field H, ω_i is the ion gyro frequency). For various ratios of α, β, and γ (two of these parameters are assumed to be small) one finds an analytical expression for the solution to the dispersion equation (cubic in ω^2) in three characteristic regions $|a| \ll \sqrt{\beta + \gamma}$, $\gamma \ll \beta$, $|a \pm \sqrt{\beta}| \ll \beta$, and $|a| \gg \sqrt{\beta + \gamma}$. On the basis of the shape of the dispersion curves, conclusions are drawn as to the nature of the interaction due to the violation of the geometric-optics approximation at points of closest approach for the branches for wave propagation in a weakly inhomogeneous medium. (auth)

14348 SELF-ACTION OF AN ELECTROMAGNETIC WAVE IN A DENSE COLLISIONLESS PLASMA. Batanov, G. M.; Silin, V. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 8, 303-6(20 Oct 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 8, 445-8(20 Oct 1971).

The penetration of a powerful electromagnetic wave through a layer of dense plasma situated in high vacuum ($\sim 10^{-6}$ mm Hg), with the maximum ratio $\omega_{0e}^2/\omega_{0i}^2 = 5$, where ω_0 is the angular frequency of the field, is studied. The plasma layer was produced by four spark sources located on the periphery of a cylindrical vacuum chamber with inside diameter 60 cm. Oscillograms with and without the plasma are given. (M.O.W.)

14349 WAVE-CONVERSION REGION IN A MICROWAVE DISCHARGE. Arkhipenko, V. I.; Budnikov, V. N.; Obukhov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 893-8(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1131-7(Jun 1971).

The location of the region of wave conversion in a plasma created by 10-cm microwaves was investigated. The measurements were performed using magnetic fields both below and above that corresponding to the electron cyclotron resonance, i.e., with values defining both the high- and medium-frequency ranges of wave conversion. The plasma was produced in argon at pressures between 10^{-1} and 10^{-3} mm Hg in a quartz vessel 70 cm long and 2.5 cm in diameter located inside a rectangular 10-cm waveguide. Small localized perturbations of the magnetic field, which cause breaks in the discharge, are employed to determine the position of the conversion region. The longitudinal distribution of the emitted light is also measured. The location of the conversion region and the longitudinal luminosity distribution are discussed in connection with wave conversion in a plasma with a two-dimensional inhomogeneity. (auth)

14350 INFLUENCE OF KINETIC EFFECTS ON WAVE PROPAGATION IN AN INHOMOGENEOUS PLASMA. Vodyanitskii, A. A.; Erokhin, N. S.; Moiseev, S. S. (Physical Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 61: No. 2, 629-41(Aug 1971). (In Russian).

Nonlocal, linear, and nonlinear effects (of the echo type in a homogeneous plasma) that lead to anomalous reflection and penetration of the waves into a plasma are investigated. The effects considered exist only in an inhomogeneous plasma. (auth)

14351 HIGH-FREQUENCY ELECTROMAGNETIC FIELD IN A PLASMA CAVITY. Trubnikov, B. A. JETP Lett. (USSR) (Engl. Transl.); 14: No. 8, 322-5(20 Oct 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 8, 473-5(20 Oct 1971).

Calculations are made of the spectrum of radiation whose pressure is balanced by the pressure of a surrounding plasma with arbitrary density profile. The geometrical-optics approximation is used in the analysis. (M.O.W.)

14352 PHYSICS OF STRONG SHOCK WAVES IN GASES. Gross, Robert A. (Columbia Univ., New York). Rend. Scu. Int. Fis. Enrico Fermi; 48: 245-77(1971).

The following topics are discussed: (1) fluid dynamic shock wave theory, (2) ionizing and plasma shock waves, (3) radiative shock waves, and (4) relativistic shock waves. (M.O.W.)

REACTOR TECHNOLOGY

Commercial Power Reactors

14353 MEASUREMENT AND CONTROL OF PWR BOILER FOR THE FIRST PLANT OF MIHAMA POWER STATION. Tsukuda, Toshio; Inoue, Toshiaki (Kansai Electric Power Co. Inc., Osaka). Karyoku Hatsuden; 22: No. 5, 510-20(May 1971). (In Japanese).

The control principle of PWR type nuclear power stations is to control output of PWR boilers according to turbine output. To perform this, an automatic control system is provided in every system, and main systems are as follows. (1) Reactor control system. (2) Pressurizer control system. (3) Feed water control system. (4) Steam dump control system. Reactivity is controlled by position control of control rods jointly with boric acid density control in the primary coolant. A three element system is adopted for level control for the boilers and some functions peculiar to the PWR boilers. Response during automatic operation can meet to ±5%/min ramp change and to ±10% stepped change of rated load. The whole system also responds up to 50% stepped decrease of the rated load without causing trip, by combined use of the steam dump control system. In addition, the protection system, nuclear instrumentation, and process instrumentation are described. (Japan)

14354 662-MW-NUCLEAR POWER PLANT STADE (KKS). Pahlke, G.; Starke, G. Energiewirt. Tagesfragen; 21: No. 3-4, 149-55(1971). (In German).

The site, the arrangement, and the design of the entire plant, as well as the reactor pressure vessel and the electric equipment are described. Also discussed are aspects of operational risks and safety. The technical specifications of the plant are given in tabular form. (INIS)

14355 CONSTRUCTION PROGRESS OF NO. 1 PLANT IN MIHAMA NUCLEAR POWER STATION. Tsukuda, Toshio; Taniguchi, Yasuo (Kansai Electric Power Co. Inc., Osaka). Karyoku Hatsuden; 22: No. 5, 482-92(May 1971). (In Japanese).

The first plant of Mihama Nuclear Power Station was completed in 48 months with delay of 4 months from initially planned schedule, and began commercial power generation on Nov. 28, 1970. The construction progress, amendment of schedule, cause of and countermeasures for delay of schedule, and progress control are described. (Japan)

14356 WHITE PAPER ON ATOMIC ENERGY, THE 15TH FEATURING EVENTS IN FISCAL 1970. Genshiryoku Hakusho; No. 15, 1-194(Aug 1971). (In Japanese).

The completion of the Fukushima and Mihama power plants accompanied by construction on a number of others; start of construction on the prototype Advanced Thermal Reactor; and completion of ship-hull construction in N.S. Mutsu are described. The white paper is presented in chapters on power reactors development, nuclear power generation, nuclear fuels, uranium enrichment, nuclear-powered ships, uses of radiations, special research projects, safety, radioactive wastes disposal, environmental radioactivities, international cooperations, safeguards, training of personnel, and the budgets. (Japan)

14357 SUPERSTRUCTURES OF DUNGENESS B NUCLEAR POWER STATION. Taylor, J. E.; Ready, R. F.; Williams, G. T. Struct. Eng.; 49: No. 11, 501-11(Nov 1971).

A detailed description is given of the structural solutions adopted in the design of the superstructures of major steel framed buildings constructed on an extremely exposed site. Particular reference is made to the design of a large three-dimensional structure at high level and to the resistance to wind forces provided by reinforced concrete floor slabs acting in conjunction with vertical braced steel frames and an internal reinforced concrete tower structure. The requirements governing the design of the superstructure frameworks are defined and brief particulars are given of a wind tunnel test associated with the high level three-dimensional structure. (auth) (UK)

Operation and Economics

14358 (DOCKET-50016-140) ENRICO FERMI ATOMIC POWER PLANT. Report for October 1971. (Power Reactor Development Co., Detroit, Mich.). 11 Jan 1972. 17p. (PRDC-EF-98). Dep. NTIS.

14359 (DOCKET-50016-141) ENRICO FERMI ATOMIC POWER PLANT. Failure to Determine Starting Time of Emergency Electrical System Diesel Generator. (Power Reactor Development Co., Detroit, Mich.). 17 Jan 1972. 2p. Dep. NTIS.

14360 (DOCKET-50130-11) PATHFINDER GENERATING PLANT. Exposure of Individuals. (Division of Compliance (AEC), Washington, D. C.). 23 Sep 1971. 4p. Dep. NTIS.

14361 (DOCKET-50155-98) BIG ROCK POINT NUCLEAR PLANT. Plutonium Utilization in Boiling Water Reactors, Phase II, Post Irradiation Examination of Four Fuel Rods After One Cycle of Operation. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Jul 1971. 46p. (NEDC-10387). Dep. NTIS. For Edison Electric Inst., New York.

Four fuel rods containing mixed oxides were irradiated in the Big Rock Point (BRP) reactor and examined in the hot cells after achieving an intermediate exposure of 7000 MWd/T (peak) during BRP Cycle No. 7 (May 1969 to February 1970). These rods were part of an original group of 32 test rods that were inserted into the core at the same time. The other 28 rods were returned to the core for continued operation in Cycle No. 8. The four rods represented four different pellet configurations: solid, dished on both ends, and cored with 0.1- and 0.2-inch-diameter holes. The rods were all in satisfactory condition at this level of burnup, and for the peak power level of about 11.7 kW/ft achieved. The extent of further cracking of the cored pellet fuel and movement of fuel particles was one specific area identified by these examinations that merits continued monitoring as higher exposures are achieved. (auth)

14362 (DOCKET-50219-162) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Areas Examined During Inspection, November 19, 1971. (Division of Compliance (AEC), Newark, N. J. Region I). 23 Dec 1971. 3p. Dep. NTIS.

Information concerning noncompliance with technical specifications is presented for availability requirements for isolation condenser loops. (D.C.C.)

14363 (DOCKET-50220-78) NINE MILE POINT NUCLEAR STATION, UNIT 1. Tripped Off Line as the Result of Surveillance Testing. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 20 Jan 1972. 2p. Dep. NTIS.

14364 (DOCKET-50220-79) NINE MILE POINT NUCLEAR STATION, UNIT 1. Crack in Drain Line From Coil of Reheater 112. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 20 Jan 1972. 1p. Dep. NTIS.

14365 (DOCKET-50237-211) DRESDEN NUCLEAR POWER STATION, UNIT 2. LPCI Valve MO-2-1501-27B Failed to Operate, December 14, 1971. (Commonwealth Edison Co., Chicago, Ill.). 13 Jan 1972. 2p. Dep. NTIS.

14366 (DOCKET-50237-212) DRESDEN NUCLEAR POWER STATION, UNIT 2. Response to Items of Noncompliance Enclosed in Letter of June 21, 1971. (Commonwealth Edison Co., Chicago, Ill.). 12 Jul 1971. 10p. Dep. NTIS.

14367 (DOCKET-50244-84) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Increase in Power Level to 1520 Megawatts (Thermal) Authorized. (Division of Reactor Licensing (AEC), Washington, D. C.). 20 Jan 1972. 30p. Dep. NTIS.

14368 (DOCKET-50245-111) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence No. AO-71-24. (Millstone Point Co., Hartford, Conn.). 11 Nov 1971. 1p. Dep. NTIS.

On November 2, 1971 the gas turbine generator failed to ignite during the monthly operability demonstration test. The failure to start was due to a faulty speed switch and bad solder connections. Corrective actions are described. (D.C.C.)

14369 (DOCKET-50245-112) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Failure of Emergency Service Water Pumps to Meet Head Requirements of Technical Specifications. (Division of Compliance (AEC), Newark, N. J. Region I). 3 Jan 1972. 6p. Dep. NTIS.

14370 (DOCKET-50247-57) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Areas Examined During Inspection, November 4-7, 11-12, 1971. (Division of Compliance (AEC), Newark, N. J. Region I). 7 Jan 1972. 3p. Dep. NTIS.

Information is presented concerning the noncompliance with technical specifications for operation of the safety injection system and availability of instrumentation. (D.C.C.)

14371 (DOCKET-50255-66) PALISADES PLANT. Failure of Two-Inch Motor-Operated Valve of High-Pressure Safety Injection System. (Consumers Power Co., Jackson, Mich.). 14 Jan 1972. 4p. Dep. NTIS.

14372 (DOCKET-50261-83) H. B. ROBINSON UNIT NO. 2. 2A Emergency Diesel Trip Due to High Crankcase Pressure. (Carolina Power and Light Co., Raleigh, N. C.). 20 Jan 1972. 1p. Dep. NTIS.

14373 (EUR-4703) LINGEN NUCLEAR POWER PLANT. Annual Report, 1970. (Kernkraftwerk Lingen G.m.b.H. (West Germany)). 12 Jul 1971. 56p. (In German). Dep. NTIS (U. S. Sales Only). EUR DM 5,10.

During January to May, November and December the power plant was used according to the grid requirements. During this time, plant utilization averaged 90%. Towards the middle of April, the reactor core reached a burnup of 8,450 MWd/+U and subsequently had to operate with fully extracted control rods. The reactor power decreased regularly by 0.34%/day. Some of the missing reactor power was replaced by additional injections of feed water into the superheater. The plant did not operate from 27 June to 10 September for the first refueling and for a turbine overhaul under guarantee. During this inspection, damage was observed on the blades of the second stages of the low-pressure rotor. All four of these stages had to be removed. At the end of September, the power plant was connected up to the grid frequency-regulation system by remote control. The progress of the operation is described in detail. The section on monitoring gives plant data on radiation protection, chemistry and physics. (auth)

14374 (EUR-4706) GUNDREMMINGEN (KRB) NUCLEAR POWER PLANT. Annual Report, 1970. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 14 Jul 1971. 66p. (In German). Dep. NTIS (U. S. Sales Only). DM 6,20.

The power plant was run at the request of the load dispatcher throughout the year at full rated power. The summer overhaul lasted six weeks. A total of 1,844 GWh was produced. The plant availability was about 85%. There were no breakdowns which led to plant outage. The scheduled short load changes spread over the year were used for control rod changing and various routine tests on control rods, main steam sealing valves and the turbine safety equipment. In order to train the shift personnel, the plant was stopped and run up again three times shortly before shut-down for overhaul. Maintenance requirements are described. A yearly average of about 0.3 mCi/sec of gamma activity was discharged with the waste air from the stack (official limit = 60 mCi/sec). A total of 1.52 Ci of activity were passed into the Danube in 8,800 m^3 of waste water (official limit = 14.4 Ci a year). (auth)

14375 (EUR-4707) LATINA NUCLEAR POWER PLANT. Annual Report, 1970. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 22 Jul 1971. 44p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR Lit. 750,-.

During this period the plant ran continuously except for a shut-down in November when the scheduled maintenance of certain plant items was carried out, in particular the main turbines. Throughout 1970 the plant was operated at about 75% of its nominal power owing to the reduction in temperature of the gas which was decided on in order to control the oxidation phenomenon affecting steels in a CO_2 environment. (auth)

14376 (RT/EC-(71)3) DESCRIPTION OF THE METHOD OF SUCCESSIVE CALCULATIONS IN THE CODE SURF 1 FOR THE ECONOMICS AND MATERIAL BALANCE EVALUATIONS: APPLICATION TO A GROWING REACTOR SYSTEM. Zironi, L.; Tanzi, V. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 22 Jun 1972. 15p. (In Italian). Dep. NTIS (U. S. Sales Only).

Power reactors systems based on different reactor types generate a total electrical power which increases with time. The present calculation method is based on the evaluation, year by year, of the materials balance and energy costs for each reactor type and for an ensemble of diverse reactors types. The present calculation method is built into the SURF 1 Code. (auth)

14377 OPERATIONAL EXPERIENCE WITH THE NUCLEAR POWER PLANT GUNDREMMINGEN (KRB). Ettemeyer, R. (Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Ger.). Energiewert. Tagesfragen; 20: No. 6, 308-11(1970). (In German).

Operational behavior, availability disturbances, and activity monitoring up to May 1970 are given. (INIS)

14378 GENERAL EXPERIENCE FROM THE CONSTRUCTION AND THE OPERATION OF THE NUCLEAR POWER PLANT OBRIGHEIM. Schenk, H. (Kernkraftwerk Obrigheim GmbH, Ger.). Energiewirt. Tagesfragen; 20: No. 6, 315-20(1970). (In German).

KWO was constructed within 4 years in spite of considerable difficulties. The operational behavior of the plant was altogether satisfying. The expectance of the plant has been fulfilled with the supply of 3 Mrd kWh to the utilities. (INIS)

14379 RADIATION LEVEL BUILDUP ON PLANT PIPING DURING SECOND CORE OPERATION OF SHIPPINGPORT PLANT. Bergmann, C. A.; Bour, D. P. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Technol.; 13: No. 3, 235-40(Mar 1972).

A comparison was made of after shutdown primary piping radiation levels between Shippingport PWR first core and second core operation. Due to changes in materials of construction, a higher power core, and other design parameters, it was thought that the radiation buildup would be different during second core operation. It was found that the radiation level due to ^{58}Co was greater during second core than first core due to use of Ni-Cr-Fe Alloy 600 steam generator tubing. All the other factors were found to essentially cancel each other. (auth)

14380 TRIAL OPERATION PROCEDURE OF MIHAMA POWER STATION (PWR). Tsukuda, Toshio (Kansai Electric Power Co. Inc., Mihama, Japan); Miyamoto, Syozo; Shibata, Mitsuo; Fujii, Gentaro. Karyoku Hatsuden; 22: No. 4, 359-83 (Apr 1971). (In Japanese).

Trial operation procedures of No. 1 unit of Mihama power station are described. Education and training of operation personnel, organization for trial operation, management of equipment and systems, outline of trial operation comprising flushing of pipework systems, examination on structural strength and leakage of various vessels and systems, function test including hot function test which is peculiar to PWRs, measurement of leakage rate of a reactor containment vessel, inspection of new fuel, fuel charging, examination of essential instrumentation and control equipment, first approach to criticality and first supply of power to grid, reactor physics test, power output test, repair and reconstruction work, and radiation control for personnel are described. Problems encountered during the trial operation have been either repaired, reorganized, or improved successfully. (Japan)

14381 OPERATIONAL CHARACTERISTICS OF JPDR-I. Ezure, Hideo (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: No. 12, 704-18(Dec 1971). (In Japanese).

Power-up tests of Japan Power Demonstration Reactor with recirculation flow (JPDR-I) were carried out in Oct. 1963. It was operated at the enhanced level up to 4,437 MWD/T and shut down in Sept. 1969. Many tests were carried out during this operation. The resulting data are very useful for the understanding of the operational characteristics and verifying the 3-dimensional boiling water reactor model. For example, it was found that the position of control rods which had been logged each hour reflected the history of burnup, and that also the temperature at which the temperature coefficient had been zero increased with burnup. The reactor physical characteristics of JPDR-I differed between high and low power operations and these characteristics, together with reactor physical and hydrodynamic characteristics, are outlined. As part of the studies on the measurements and analysis of burnup, a series of destructive and undestructive tests was carried out. The absolute γ-intensity of ^{137}Cs and isotopes ratios of U and Pu were also measured. (auth)

Safety and Siting

14382 (DOCKET-1151-50) ELK RIVER REACTOR. Technical Specifications, Change No. 16. (Division of Reactor Licensing (AEC), Washington, D. C.). 11 Jan 1972. 3p. Dep. NTIS.

Revised technical specifications are presented concerning the addition of an access hatch and an additional opening in the containment building to accommodate the shipping containers and large components during dismantling procedures. (D.C.C.)

14383 (DOCKET-1155-149) LA CROSSE BOILING WATER REACTOR. Information on the Installation of Main Steam Line Safety Valves and Headers. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 19 Jan 1972. 5p. Dep. NTIS.

14384 (DOCKET-1155-150) LA CROSSE BOILING WATER REACTOR. Review of Relief Valve Installation. (Dairyland Power Cooperative, La Crosse, Wis.). 13 Jan 1972. 12p. Dep. NTIS.

14385 (DOCKET-1155–151) LA CROSSE BOILING WATER REACTOR. Analysis of Emergency Core Cooling System. (Dairyland Power Cooperative, La Crosse, Wis.). 18 Jan 1972. 6p. Dep. NTIS.

14386 (DOCKET-50003–95) INDIAN POINT STATION, UNIT 1. Fast Insertion of Control Rods. (Consolidated Edison Co. of New York, Inc., New York). 14 Jan 1972. 4p. Dep. NTIS.

14387 (DOCKET-50003–96) INDIAN POINT STATION, UNITS 1 AND 2. Information Relating to Reactor Scram Circuit Breakers. (Division of Compliance (AEC), Newark, N. J. Region I). 7 Jan 1972. 5p. (DOCKET-50247–56). Dep. NTIS.

14388 (DOCKET-50010–101) DRESDEN NUCLEAR POWER STATION, UNITS 1, 2, AND 3. QUAD-CITIES STATION, UNITS 1 AND 2. Installation of the Main Steam Line Safety Valves and Headers. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 17 Jan 1972. 4p. (DOCKET-50237–210; DOCKET-50249–115; DOCKET-50254–62; DOCKET-50265–54). Dep. NTIS.

14389 (DOCKET-50016–139) ENRICO FERMI ATOMIC POWER PLANT. Location of Pressure Relief Valves. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 17 Jan 1972. 4p. Dep. NTIS.

14390 (DOCKET-50029–162) YANKEE NUCLEAR POWER STATION. Information Concerning Reactor Scram Circuit Breakers. (Division of Compliance (AEC), Newark, N. J. Region I). 8 Dec 1971. 4p. Dep. NTIS.

14391 (DOCKET-50029–163) YANKEE NUCLEAR POWER STATION. Quality Assurance Program, Supplemental Information. (Yankee Atomic Electric Co., Westboro, Mass.). 12 Jan 1972. 5p. Dep. NTIS.

14392 (DOCKET-50029–164) YANKEE NUCLEAR POWER STATION. Revised Loss of Coolant Analysis. (Yankee Atomic Electric Co., Westboro, Mass.). 15 Jan 1972. 61p. Dep. NTIS.

14393 (DOCKET-50133–72) HUMBOLDT BAY POWER PLANT, UNIT 3. No Safety Valve Headers of Turkey Point Type. (Division of Compliance (AEC), Berkeley, Calif. Region V). 21 Dec 1971. 2p. Dep. NTIS.

14394 (DOCKET-50133–73) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Technical Specifications, Change No. 36. (Division of Reactor Licensing (AEC), Washington, D. C.). 21 Jan 1972. 3p. Dep. NTIS.

Revised technical specifications are presented concerning leakage rate limits and surveillance requirements for the primary cooling system. (D.C.C.)

14395 (DOCKET-50146–103) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. Information Concerning Reactor Scram Circuit Breakers. (Division of Compliance (AEC), Newark, N. J. Region I). 8 Dec 1971. 6p. Dep. NTIS.

14396 (DOCKET-50155–97) BIG ROCK POINT NUCLEAR PLANT. PALISADES PLANT. Installation of Main Steam Relief Valves. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 17 Jan 1972. 4p. (DOCKET-50255–64). Dep. NTIS.

14397 (DOCKET-50171–96) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Information Concerning Main Steam Relief Valves. (Division of Compliance (AEC), Newark, N. J. Region I). 16 Dec 1971. 2p. Dep. NTIS.

14398 (DOCKET-50171–97) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Areas Examined During Inspection of December 14–16, 1971. (Division of Compliance (AEC), Newark, N. J. Region I). 17 Jan 1972. 2p. Dep. NTIS.

Results of inspection are presented concerning administrative controls, reactor operations, surveillance test records, emergency diesel generator operation, quality assurance procedures, emergency procedures, emergency control rod battery testing, and maintenance for motor operated valves. (D.C.C.)

14399 (DOCKET-50206–138) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Main Steam Relief Valve Headers. (Division of Compliance (AEC), Berkeley, Calif. Revion V). 22 Dec 1971. 7p. Dep. NTIS.

14400 (DOCKET-50206–139) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Technical Specifications, Change No. 7. (Division of Reactor Licensing (AEC), Washington, D. C.). 13 Jan 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning the allowable leakage rate for the primary cooling system and the replacement of blind flanges with valves on the exterior side of the ventilation system isolation valves. (D.C.C.)

14401 (DOCKET-50206–140) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Technical Specification, Change No. 4. (Division of Reactor Licensing (AEC), Washington, D. C.). 18 Jan 1972. 7p. Dep. NTIS.

Revised technical specifications are presented concerning insertion limits for the control rod groups. (D.C.C.)

14402 (DOCKET-50213–128) HADDAM NECK PLANT. Change to Secondary Safety Valve Installation. (Connecticut Yankee Atomic Power Co., Hartford). 21 Jan 1972. 6p. Dep. NTIS.

14403 (DOCKET-50219–161) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Information Concerning Main Steam Line Headers. (Division of Compliance (AEC), Newark, N. J. Region I). 10 Jan 1972. 4p. Dep. NTIS.

14404 (DOCKET-50245–113) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Information Concerning Main Steam Relief Valve. (Division of Compliance (AEC), Newark, N. J. Region I). 10 Jan 1972. 4p. Dep. NTIS.

The location and design specifications for safety valves of the main steam line are presented. Materials used in the safety valves and piping system are listed. (D.C.C.)

14405 (DOCKET-50250–60) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Supplement No. 43. (Florida Power and Light Co.). 19 Jan 1972. 34p. (DOCKET-50251–54). Dep. NTIS.

Revised information is presented concerning auxiliary systems, waste disposal systems, radiation protection, operations, and technical specifications. (D.C.C.)

14406 (DOCKET-50250–61) TURKEY POINT PLANT, UNIT 3. Structural Integrity Test Report and Containment Surveillance During the Structural Integrity Test. (Florida Power and Light Co.). 19 Jan 1972. 174p. Dep. NTIS.

14407 (DOCKET-50250–62) TURKEY POINT PLANT, UNITS 3 AND 4. Areas Examined During Inspection, October 19–22, 1971. (Division of Compliance (AEC), Atlanta, Ga. Region II). 21 Jan 1972. 2p. (DOCKET-50251–55). Dep. NTIS.

Results of inspection are presented concerning personnel changes, startup procedures, electrical systems installation, Unit 3 testing and loading procedures, and site security. (D.C.C.)

14408 (DOCKET-50255–65) PALISADES PLANT. Final Safety Analysis Report, Amendment No. 26. (Consumers Power Co., Jackson, Mich.). 12 Jan 1972. 2p. Dep. NTIS.

Additional information is presented concerning the assumptions and models used in the performance evaluation of the emergency core cooling system. (D.C.C.)

14409 (DOCKET-50259–33) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Environmental Statement. (Tennessee Valley Authority, Chattanooga). 14 Jul 1971. 185p. (DOCKET-50260–32; DOCKET-50296–31). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. Ecological, hydrological, and meteorological data for the reactor site are included. The effects of reactor operations on the environment are analyzed. (D.C.C.)

14410 (DOCKET-50259–34) BROWNS FERRY NUCLEAR PLANT, UNITS 1 AND 2. Correspondence Relating to Inspection of Fabrication of Pressure Vessel. (Tennessee Valley Authority, Chattanooga). 12 Jul 1971. 12p. (DOCKET-50260–33). Dep. NTIS.

14411 (DOCKET-50263–100) MONTICELLO NUCLEAR GENERATING PLANT. Installation of Main Steam Line Safety Valves and Headers. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 17 Jan 1972. 4p. Dep. NTIS.

14412 (DOCKET-50263–101) MONTICELLO NUCLEAR GENERATING PLANT. Technical Specifications, Change No. 2. (Division of Reactor Licensing (AEC), Washington, D. C.). 14 Jan 1972. 15p. Dep. NTIS.

Revised technical specifications are presented concerning the gaseous radioactive waste disposal system. (D.C.C.)

14413 (DOCKET-50267–37) FORT ST. VRAIN NUCLEAR GENERATING STATION. Final Safety Analysis Report, Amendment No. 24. (Public Service Co. of Colorado, Denver). 3 Jan 1972. 326p. Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the Fort St. Vrain Power Reactor Unit 1. (D.C.C.)

14414 (DOCKET-50271-69) VERMONT YANKEE NUCLEAR POWER STATION. Final Safety Analysis Report, Proposed Change. (Vermont Yankee Nuclear Power Corp., Rutland). 19 Jan 1972. 10p. Dep. NTIS.

Additional information is presented concerning the secondary containment negative pressure requirements and locations of area radiation monitoring system sensors. (D.C.C.)

14415 (DOCKET-50271-70) VERMONT YANKEE NUCLEAR POWER STATION. Areas Examined During Inspections, October 25-28, November 9-12, 22-24, 29-30, and December 1, 21-23, 1971 (Two Letters). (Division of Compliance (AEC), Newark, N. J. Region I). 7 Jan 1972. 2p. Dep. NTIS.

Results of inspections are presented for electrical systems, fuel elements, cooling system, diesel generator, testing procedures, and operation procedures. (D.C.C.)

14416 (DOCKET-50280-65) SURRY POWER STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 28. (Virginia Electric and Power Co., Richmond). 11 Nov 1971. 5p. (DOCKET-50281-61). Dep. NTIS.

Additional information is presented concerning the power supply to isolation valves during reactor operation, fracture characteristics of welds, pressurizer spray line with sensitized stainless steel pipe, loose parts monitoring program, recirculation spray pump motor test, reactor operation, startup personnel, emergency plan, containment pressure transients, and security program. (D.C.C.)

14417 (DOCKET-50281-62) SURRY POWER STATION, UNIT NO. 2. NORTH ANNA POWER STATION, UNIT 1. Correspondence Relating to Pressure Vessel Fabrication. (Division of Compliance (AEC), Washington, D. C.). 1 Sep 1971. 9p. (DOCKET-50338-36). Dep. NTIS.

14418 (DOCKET-50281-63) SURRY POWER STATION, UNIT 2. Areas Examined During Inspection, October 27-29, 1971. (Division of Compliance (AEC), Atlanta, Ga. Region II). 21 Jan 1972. 2p. Dep. NTIS.

Results of inspection are presented concerning electrical cable and equipment installation, cooling system, and Class 1 piping installation. (D.C.C.)

14419 (DOCKET-50282-47) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNIT 1. Comments on Inspection Report, November 30, 1971. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 30 Dec 1971. 6p. (DOCKET-50306-46). Dep. NTIS.

Additional information is presented concerning the installation of a battery charger and the clarity of radiographs for containment spray system welds. (D.C.C.)

14420 (DOCKET-50282-48) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Correspondence Relating to Fabrication of Reactor Pressure Vessels. (Division of Compliance (AEC), Washington, D. C.). 26 Apr 1971. 4p. DOCKET-50306-47). Dep. NTIS.

14421 (DOCKET-50285-54) FORT CALHOUN STATION, UNIT 1. Discussion and Findings Relating to Suspension of Construction Permit Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 26 Nov 1971. 10p. Dep. NTIS.

14422 (DOCKET-50295-27) ZION STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment No. 11. (Commonwealth Edison Co., Chicago, Ill.). 27 Feb 1969. 24p. (DOCKET-50304-40). Dep. NTIS.

Requested additional information is presented concerning the containment structure. (D.C.C.)

14423 (DOCKET-50295-37) ZION STATION, UNITS 1 AND 2. Discussions and Findings Relating to Suspension of Construction Permit Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Nov 1971. 15p. (DOCKET-50304-36). Dep. NTIS.

14424 (DOCKET-50295-38) ZION STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 3. (Commonwealth Edison Co., Chicago, Ill.). 28 Nov 1967. 546p. (DOCKET-50304-37). Dep. NTIS.

Requested additional information is presented on the following topics: reactor site; design of Class 1 equipment; containment structure; instrumentation and control systems; plant systems; engineered safeguards; and accident analysis. (D.C.C.)

14425 (DOCKET-50295-39) ZION STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 4. (Commonwealth Edison Co., Chicago, Ill.). 28 Nov 1967. 431p. (DOCKET-50304-38). Dep. NTIS.

Additional information is presented on the following topics: earthquake stress limits for piping systems and pressure vessel; containment structure stress limits and inspection requirements; reactor site; accident analysis; and instrumentation and control systems. (D.C.C.)

14426 (DOCKET-50295-40) ZION STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 5. (Commonwealth Edison Co., Chicago, Ill.). 29 Jan 1968. 196p. (DOCKET-50304-39). Dep. NTIS.

Additional data are presented concerning design parameters and operations aspects of the Zion Power Reactor Units 1 and 2. (D.C.C.)

14427 (DOCKET-50309-47) MAINE YANKEE ATOMIC POWER STATION. Discussion and Findings Relating to Suspension of Construction Permit Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Nov 1971. 16p. Dep. NTIS.

14428 (DOCKET-50309-48) MAINE YANKEE ATOMIC POWER STATION. Areas Examined During Inspection, December 15-17, 1971. (Division of Compliance (AEC), Newark, N. J. Region I). 11 Jan 1972. 1p. Dep. NTIS.

Results of inspection are presented for safety injection system tanks, core structures, piping systems, cooling system, and construction activities. (D.C.C.)

14429 (DOCKET-50313-36) ARKANSAS NUCLEAR ONE, UNITS 1 AND 2. Areas Examined During Inspection, December 6-10, 1971. (Division of Compliance (AEC), Atlanta, Ga. Region II). 24 Jan 1972. 2p. (DOCKET-50368-22). Dep. NTIS.

Results of inspection are presented for electrical systems, cooling system, containment structure, piping systems, and construction activities. (D.C.C.)

14430 (DOCKET-50315-56) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Comments on Construction of Control Panels at Harlo Corporation. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 29 Nov 1971. 6p. (DOCKET-50316-56). Dep. NTIS.

14431 (DOCKET-50321-29) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Final Safety Analysis Report, Amendment No. 11. (Georgia Power Co., Atlanta). 19 Jan 1972. 194p. Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the Edwin I. Hatch Power Reactor Unit 1. (D.C.C.)

14432 (DOCKET-50324-33) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Additional Information for Use in Consideration of the Environmental Impact. (Carolina Power and Light Co., Raleigh, N. C.). 4 Jan 1972. 15p. (DOCKET-50325-33). Dep. NTIS.

Additional information is presented concerning thermal effluents, circulating water system discharge canal, and transmission lines. (D.C.C.)

14433 (DOCKET-50327-23) SEQUOYAH NUCLEAR PLANT, UNIT 1. Correpondence Relating to Fabrication of Pressure Vessel. (Division of Compliance (AEC), Washington, D. C.). 23 Jul 1971. 7p. Dep. NTIS.

14434 (DOCKET-50338-35) NORTH ANNA POWER STATION, UNITS 1 AND 2. Discussion and Findings Relating to Suspension of Construction Permits Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Nov 1971. 29p. (DOCKET-50339-34). Dep. NTIS.

14435 (DOCKET-50338-37) NORTH ANNA POWER STATION, UNITS 1 AND 2. Areas Examined During Inspection, October 5-6, 1971. (Division of Compliance (AEC), Atlanta, Ga. Region II). 21 Jan 1971. 2p. (DOCKET-50339-35). Dep. NTIS.

Results of inspection are presented for cooling water dam and intake structure, containment structure, auxiliary and service buildings, and safety injection system. (D.C.C.)

14436 (DOCKET-50346-24) DAVIS-BESSE NUCLEAR POWER STATION. Discussion and Findings Relating to Suspension of Construction Permit Pending NEPA Environmental Review. (Division of Reactor Licensing (AEC), Washington, D. C.). 30 Nov 1971. 27p. Dep. NTIS.

14437 (DOCKET-50348-33) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Reasons Why Construction Should Not be Suspended Pending Completion of NEPA Review, Supplemental Information: Two Letters. (Alabama Power Co., Birmingham). 11 Jan 1972. 6p. (DOCKET-50364-27). Dep. NTIS.

14438 (DOCKET-50348-34) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Reasons Why Construction Should Not be Suspended Pending Completion of NEPA Review, Revised Page 35. (Alabama Power Co., Birmingham). 18 Jan 1972. 3p. (DOCKET-50364-28). Dep. NTIS.

14439 (DOCKET-50363-19) FORKED RIVER NUCLEAR POWER STATION. Environmental Report, Construction Permit Stage. (Jersey Central Power and Light Co., Morristown, N. J.). 24 Jan 1972. 626p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Ecological and meteorological data for the reactor site are included. (D.C.C.)

14440 (DOCKET-50369-19) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Areas Examined During Inspection, November 22-24, 1971. (Division of Compliance (AEC), Atlanta, Ga. Region II). 24 Jan 1972. 1p. (DOCKET-50370-18). Dep. NTIS.

Inspection results are presented for the service water pond dam and erection of the concrete batch plant. (D.C.C.)

14441 (DOCKET-50373-13) LA SALLE COUNTY STATION, UNITS 1 AND 2. Environmental Report, Supplement 1. (Commonwealth Edison Co., Chicago, Ill.). 17 Jan 1972. 72p. (DOCKET-50374-13). Dep. NTIS.

Information concerning radioactive discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

14442 (DOCKET-50376-26) AGUIRRE NUCLEAR PLANT, UNIT 1. Environmental Report, Supplement No. 2. (Puerto Rico Water Resources Authority, San Juan). 17 Jan 1972. 432p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Ecological, hydrological, and meteorological data for reactor site are included. Financial aspects of reactor operation are described. (D.C.C.)

14443 (DOCKET-50376-27) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Area Examined During Inspection, October 20-22, 1971. (Division of Compliance (AEC), Atlanta, Ga. Region II). 24 Jan 1972. 1p. Dep. NTIS.

Inspection of the quality assurance program procedures is described. (D.C.C.)

14444 (DOCKET-50387-14) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS NO. 1 AND NO. 2. Preliminary Safety Analysis Report, Amendment No. 5. (Pennsylvania Power and Light Co., Allentown). 6 Jan 1972. 245p. (DOCKET-50388-14). Dep. NTIS.

Revised design parameters of the Susquehanna Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

14445 (DOCKET-50397-10) HANFORD NO. 2 NUCLEAR POWER PLANT. Environmental Report, Amendment 1. (Washington Public Power Supply System, Kennewick). 14 Jan 1972. 377p. Dep. NTIS.

Revised and additional data are presented concerning radioactive and thermal discharges from the reactor. The effects of reactor operations on the environment are analyzed. (D.C.C.)

14446 (DOCKET-50400-8) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Appropriateness of a Single Review for the Four Nuclear Units. (Carolina Power and Light Co., Raleigh, N. C.). 12 Jan 1972. 15p. (DOCKET-50401-8; DOCKET-50402-8; DOCKET-50403-8). Dep. NTIS.

The construction schedule for the Shearon Harris Power Reactor Units 1, 2, 3, and 4 is presented. Diagrams of the plant layout and construction sequence for each building are included. (D.C.C.)

14447 (UCRL-73567) GOALS OF COST-BENEFIT ANALYSIS IN ELECTRICAL POWER GENERATION. Watson, Donald E. (California Univ., Livermore. Lawrence Livermore Lab.). 11 Nov 1971. 6p. (CONF-711123-2). Dep. NTIS.

From Symposium on risk vs benefit analysis: solution or dream; Los Alamos, N. Mex. (11 Nov 1971).

Cost-benefit analysis is a promising vehicle for promoting meaningful communication between the technological and the public-policy-making communities. However, the realization of this potential depends on the realistic assessment of the goals and limitations of cost-benefit analysis. Risk-acceptability evaluation is distinguished from risk evaluation, and is considered to be relevant to the overall goals of cost-benefit analysis. As an example of the use of comparative risk evaluation, the risks of carcinogenesis from fossil-fueled and nuclear power generation are compared. Despite considerable uncertainty in establishing the magnitude of the risks, it is shown that current levels of pollution from fossil-fueled power plants constitute a risk that is probably considerably higher than that from projected nuclear plants. (4 references) (auth)

14448 (WASH-1198) REPORT ON RELEASES OF RADIOACTIVITY FROM POWER REACTORS IN EFFLUENTS DURING 1970. (Division of Compliance (AEC), Washington, D. C.). Oct 1971. 9p. Dep. NTIS.

14449 (WCAP-7822) INDIAN POINT UNIT NO. 2 REACTOR INTERNALS MECHANICAL ANALYSIS FOR BLOWDOWN EXCITATION. Bohm, G. J. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 105p. Dep. NTIS.

In the design of nuclear reactor pressure vessel internals, accident conditions that could create pressure wave propagation inside the reactor are postulated. The responses of the vessel internals of the Indian Point Nuclear Generating Station-Unit No. 2 (IPP-2) pressurized water reactor (PWR) under the excitation produced by a complete severance of a reactor coolant system pipe are analyzed. Assuming that a double-ended pipe break occurs in a very short period of time (on the order of a few milliseconds), a rapid pressure drop at the break produces a disturbance which propagates inside the primary loop and excites the reactor internals both vertically and transversely. A detailed study of the resulting structural response is presented. The behavior of the reactor internals under seismic excitation (vertical and horizontal) is also investigated; the response is conservatively superimposed on that of the loading imposed by the sudden double-ended break of a coolant pipe to obtain the maximum stresses and deflection. The results obtained from the analysis are compared with allowable values to establish safety margins of the structures and the ability to operate the emergency core-cooling system. (12 references) (auth)

14450 NUCLEAR POWER STATION PHILIPPSBURG. Moll, W. (Kraftwerk Union AG, Frankfurt am Main). Energiewirt. Tagesfragen; 21: No. 3-4, 141-8(1971). (In German).

A description is given of the site and the general plan of the power station, the nuclear steam generation system, control of the reactor power and exchange of fuel elements, auxiliary and accessory reactor equipment, and the main thermal cycle of the conventional part. Technical specifications of the reactor are added in a table. (INIS)

14451 ASSESSMENT OF PERSONNEL DOSES FROM ^{3}He, ^{14}C, AND ^{35}S PRODUCED IN DUNGENESS B NUCLEAR POWER STATION. Clarke, D. A. (Atomic Power Constructions Ltd., Sutton, Eng.). pp 225-30 of Protection Against Low Energy or Short Range Radiations and the Biological Effects of Radiation. Le Vesinet, France: Service Central de Protection Contre les Rayonnements Ionisants (1971).

From first European congress on radiation protection and exhibition on equipment using low energy and short range radiation dosimetry; Menton, France (9 Oct 1968). See CONF-681013.

The low energy beta emitters ^{3}H, ^{14}C and ^{35}S are formed by various neutron reactions on materials or impurities present in reactors. The expected activities of these isotopes in the Dungeness B AGR nuclear power station are assessed. The main source of tritium is expected to be the (n,α) reaction on the lithium impurity in graphite. It is produced also in the fission process, but very little is expected to be released from the fuel elements. On pessimistic assumptions, the maximum annual discharge of tritiated water may be high, but this can be made with negligible radiological hazard. The main source of ^{14}C is expected to be the (n,p) reaction on residual nitrogen present after filling the reactor with air for boiler inspection. The variation of ^{14}C activity in the coolant with time is presented. The main source of ^{35}S is expected to be the (n,p) reaction on the chlorine impurity in graphite. The chemistry of ^{35}S release is briefly mentioned. It is shown that dose to personnel and members of the public from these sources in gaseous and liquid effluent from Dungeness B will be well below the ICRP limits. (France)

Power Reactor Development

Refer also to abstract 11971.

14452 (ANL-7887) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, NOVEMBER 1971. (Argonne National Lab., Ill.). 29 Dec 1971. Contract W-31-109-eng-38. 180p. Dep. NTIS.

Highlights of project activities for November 1971 are summarized. The EBR-2 operations, fuels and materials studies, and engineering development activities are reported. LMFBR design support programs are reviewed. Instrumentation development for LMFBR and FFTF is described. Sodium monitoring and sampling systems for the LMFBR and FFTF are reviewed. Performance characteristics of LMFBR fuel elements are described. Fuel processing methods are discussed. Physics measurements are presented for ZPR-3 Assembly 53, ZPR-6 Assembly 7, and ZPPR Assembly 2. LMFBR fuel element failure characteristics are analyzed. Thermal effluent studies in Lake Michigan are reviewed. (D.C.C.)

14453 (WASH-1094) GUIDE FOR THE LICENSING OF FACILITY OPERATORS, INCLUDING SENIOR OPERATORS. AEC Licensing Guide, Operator Licensing Program. (Division of Reactor Licensing (AEC), Washington, D. C.). Nov 1965. 63p. GPO $0.40.

The U. S. Atomic Energy Commission regulations for prescribing uniform conditions for licensing operators of production and utilization facilities, for determining qualifications of operators, and for issuing licenses are described and the administration of the regulations is examined. The guide is principally addressed to operators of reactor facilities. (H.D.R.)

14454 SURVEY OF SPAIN. Otero Navascues, Jose M. (Junta de Energia Nuclear, Madrid); Jodra, L. G.; Cortines, M. G.; Pascual, F.; Kaibel, Enrique; Cabrera, Jose. Nucl. Eng. Int.; 17: No. 188, 25-40(Jan 1972).

The survey consists of six articles in which nuclear activities in Spain are examined. Prospects for nuclear energy are discussed together with the organization and activities of the Junta de Energia Nuclear. Uranium resources and Spanish interest in nuclear fuel cycles, the most prominent aspects of which are fuel element fabrication and isotopic enrichment, are described. The participation of Spanish industry in the manufacture of components for nuclear reactors and the problems and prospects of the industry are examined. Brief status summaries are presented for existing and planned nuclear stations in Spain. A table of the nuclear industry gives details of industrial and governmental organizations. (UK)

14455 HOT-STEAM REACTOR GROSSWELZHEIM. Peuster, K. Energiewirt. Tagesfragen; 20: No. 6, 307-8(1970). (In German).

A brief description is presented of the HDR as pilot plant for the testing of fuel elements and reactor components. (INIS)

14456 INVESTIGATIONS FOR THE DESIGN OF A HIGH TEMPERATURE REACTOR CONTAINING INGOT MOLDED FUEL ELEMENTS. Schloesser, J.; Schmidt, E.; Vollmer, H. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). Energiewirt. Tagesfragen; 21: No. 3-4, 158-61(1971). (In German).

A description is given of the design work of a 600 MW(e)-high temperature reactor. The core consists of hexagonal graphite ingots which contain the fuel in the form of rods. An optimization has been accomplished with regard to the electricity generating cost. The impacts of continuous and discontinuous charging are discussed in detail. Finally the most important design data of the components of the primary cycle are given. (INIS)

14457 POLLUTION CONTROL USING ADVANCED ENERGY GENERATION SYSTEMS. Barthelemy, Robert R. (Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio). pp 1-5 of Technology Utilization Ideas for the 70's and Beyond. /Forbes, F. W. (ed.). Tarzana, Calif.; American Astronautical Society (1971).

From Conference on technology utilization ideas for the 70's and beyond; Winrock, Ark. (30 Oct 1970).

One of the most critical problems facing the world today is the increase in environmental pollution. The three most important forms of pollution are thermal heating of our water supplies, chemical pollution of the atmosphere and, to a lesser degree, the introduction of waste (nuclear and chemical) into the soil. This adverse situation arises primarily because it is impossible to convert all of the latent energy of chemical and nuclear fuels into desirable directed energy, either kinetic or electrical. Short of moving our conversion and manufacturing systems into space (which may eventually become necessary), our only technological recourse is to minimize the contaminating effects of our major conversion processes. Recent developments in the fields of high temperature energy sources and advanced energy conversion processes could be utilized to significantly improve the processes used for generating electrical power. Although electrical power generation is not the sole contributor to environmental pollution, it plays a major part. The use of high temperature nuclear reactor thermal systems coupled to high efficiency generation systems could reduce the thermal pollution of generation plants several fold and completely eliminate particulate pollution of the atmosphere, with little or no contamination of the earth with nuclear by-products. Gaseous core nuclear reactors are being studied in basic and exploratory development for future space rocket uses. Such a system, however, could produce a power generation system working fluid at 4000°K. Exploratory development of magnetohydrodynamic (MHD) generators for airborne and space system power has shown high efficiency operation if high temperature gases are used. Coupled to 4000°K gases, these generators could convert 60-70% of the gas thermal energy into electrical power. This efficiency is 50% higher than the most modern advanced steam turbine plant and over 100% more efficient than conventional nuclear power plants. The amount of thermal pollution of cooling streams should be reduced by a factor of 3 to 5. In addition, the decreased cost of electrical power through improved efficiency operation would result in a savings of about one billion dollars/year at the present consumption rate. (6 references) (auth)

14458 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Jackson, George Oliver (to United Kingdom Atomic Energy Authority). British Patent 1,256,874. 15 Dec 1971. Filed 23 Feb 1968.

Reference is made to reactors of the type cooled by, and whose core is submerged in a pool of, a freezable liquid, and the aim is stated to be reduction of the capital cost of large liquid metal cooled fast breeder power reactors and also increasing the safety thereof. In the system described the liquid coolant is contained by a continuous layer of frozen coolant supported by a suitable structure. The freezable coolant may comprise a liquid metal, polyphenyl, or fused salt, and the support structure may be of suitably lined concrete and provided with cooling pipes extending over the surface. These pipes may be in closed loops and may contain NaK alloy, the loops including a cooler cooled by a forced air draught. (UK)

14459 DEVELOPMENT OF NUCLEAR POWER PLANTS WITH HELIUM COOLING IN THE FEDERAL REPUBLIC OF GERMANY. Bammert, K.; Klein, R. (Univ., Hanover). pp 29-62 of Helium Society. /Blizin, Jerald (comp.). Washington, D. C.; Helium Society (1971).

From Helium Society Symposium; Washington, D. C. (3 May 1971).

The main aspects and circumstances of the development of nuclear power plants with helium cooling in the Federal Republic of Germany are explained. This development aims at the construction and operation of commercial helium-cooled high-temperature reactors of high power output, with the idea of applying first the two-cycle design with steam turbine and then the single-cycle design with helium turbine. The most important reasons for the development of nuclear power plants with helium-cooled reactors are given. In this connection the high-temperature reactor systems play a prominent part. A survey of the present situation in the field of high-temperature reactors is included. The most important phases of future development are indicated and the time limits of these are given. 14 references. (auth)

14460 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Jackson, George Oliver (to United Kingdom Atomic Energy Authority). British Patent 1,258,763. 30 Dec 1971. Filed 23 Feb 1968.

Reference is made to reactors employing liquid coolant contained in the reactor core vessel. An established practice with such systems is to provide double walling to take care of possible leaks, but this is expensive. The object of the system described is to provide a liquid-containing system that has all the advantages of a double-walled vessel, but gives cost savings, making use of already existing structure. The core vessel is single-walled and the liquid-containing part of the vessel is surrounded by a concrete vault lined with metal; the vault thus provides a leak jacket. Cooling means are provided in the interspace to avoid undue heating of the concrete. Thermal insulation may be provided in the interspace, and the latter may contain convection circulated inert gas. (UK)

14461 CONTINUOUS REMOVAL OF FISSION PRODUCTS IN A NITRIDE-FUELED REACTOR. Anderson, R. N.; Parlee, N. A. D. (Stanford Univ., Calif.). Nucl. Technol.; 13: No. 3, 297-300(Mar 1972).

A nitride fueled nuclear reactor is proposed in which the fission products are selectively removed from the reactor in a liquid alloy, and makeup fuel added during operation. The con-

cept is based on the behavior of the nitrogen-nitride equilibria in liquid fuel-tin alloy systems where an actinide nitride fuel in contact with liquid metal alloy will reversibly form or dissolve depending on the temperature, the nitrogen pressure on the system, and the fuel content of the alloy. Consequently, controlling the temperature and the nitrogen pressure over the solid nitride fuel-liquid alloy phases will result in a critical mass of nitride being maintained and the fission products that form being dissolved in the liquid alloy above it. The liquid alloy phase may be removed, the fission products eliminated, and the alloy recycled to the reactor with or without makeup fuel additions. (12 references)(auth)

14462 NUCLEAR REACTOR WITH LIGHT WATER COOLING AND A FUEL ELEMENT VESSEL WITHIN A PRESSURE TIGHT REACTOR BUILDING. Kumpf, Herman (to Siemens AG). German Patent 1,514,702. 2 Oct 1969. Filed 11 Mar 1966. (In German).

A nuclear reactor with light water cooling and a fuel element container within a pressure-tight reactor building is described. The area for the operating personnel above the fuel element container is shielded separately. Airlocks for transport devices and personnel are provided. The space over the reactor is flooded during the exchange of reactor fuel elements and is connected with the fuel element container by a removable wall section. A common manipulation bridge is provided for both spaces. (tr-auth)

14463 LIQUID COOLED NUCLEAR REACTOR. Fruth, Hans (to Siemens AG). German Patent 1,439,219. 31 Jul 1969. Filed 13 Mar 1963. (In German).

A reactor with liquid moderator and a protective gas over the moderator is described. The circulation of the protective gas is provided by a water compressor. (tr-auth)

14464 NUCLEAR REACTOR WITH OSCILLATING LIQUID COOLANT MODERATOR. Walton, Gilbert Northcott (to United Kingdom Atomic Energy Authority). U. S. Patent 3,620,315. 16 Nov 1971. Filed 1 May 1968.

A nuclear reactor is described having a negative temperature coefficient of reactivity and having coolant moderator means wherein as the temperature of the core decreases below a mean value more cooling effect is applied to the core and as the temperature of the core increases above said mean value less cooling effect is applied to the core, whereby the reactivity of the core undergoes a sustained self-excited oscillation and the temperature also oscillates about said mean value. (Official Gazette)

14465 TESTS OF MULTIELEMENT THERMIONIC EXPERIMENTAL ASSEMBLIES AT UNIVERSAL LOOP DEVICE. Berzhatyi, V. I.; Gribоedov, N. A.; Gritsaenko, V. P.; (and others). At. Energ. (USSR); 31: No. 6, 585-8(Dec 1971). (In Russian).

Reactor tests of the experimental assemblies consisting of electrogenerating channels are described. Each channel involves 6 series-connected electrogenerating elements. An assembly contains an ampule and a bar. Besides the electrogenerating channel, an autonomous system for removing fission products, a cesium feed and temperature stabilization system, heating elements and sensors for measuring electrogenerating channel parameters are also set in the ampule. The biological shield, vacuum and gas pipelines, thermocouple and electrical cables are placed in the bar. Two experimental assemblies were tested. Power densities of 5 w/cm^2 for 75 hours and 8–10 w/cm^2 for 220 hours were obtained during the tests. In both cases slight leaks were observed in the channel shells. Estimates of the maximum (1750–1960°C) emitter temperatures for power densities ranging from 5 to 10 w/cm^2 are presented. Efficiencies of the assemblies tested were from 10 to 14 percent. Tests were performed at the universal loop device of the light-water reactor. (auth)

14466 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Gratton, Charles Peter; Hooper, Alan Thomas; Kenward, Alan Crowhurst (to United Kingdom Atomic Energy Authority). British Patent 1,256,703. 15 Dec 1971. Filed 7 Feb 1968.

A gas cooled reactor core design incorporates porous fuel elements of coated particle fuel arranged in the form of a layer or bed. The coolant is introduced to an inlet face of an element and removed by flowing along an outlet face. To offset a rise in pressure in the coolant flow direction, an arrangement is provided to reduce the flow area for coolant where the mass flow of coolant reduces. (H.D.R.)

14467 NUCLEAR REACTORS WITH POROUS FUEL. Gratton, Charles Peter; Hooper, Alan Thomas; Kenward, Alan Crowhurst; (and others) (to United Kingdom Atomic Energy Authority) British Patent 1,256,701. 15 Dec 1971. Filed 7 Feb 1968.

A gas cooled reactor core design incorporates porous fuel elements of coated particle fuel arranged in the form of a layer or bed. Gas coolant is supplied to one face of each element and withdrawn from the opposite face after having traversed the fuel. Means are provided for compensating for the effect of coolant pressure gradients on pressure drop across the fuel. In this manner inequalities in coolant distribution are reduced. (H.D.R.)

14468 NONLINEAR PROGRAMMING FOR FAST BREEDER DESIGN OPTIMIZATION. Kobayashi, Tomofumi; Kato, Mihoko; Inoue, Kotaro (Hitachi Ltd., Japan). Nippon Genshiryoku Gakkaishi; 13: No. 12, 694-703(Dec 1971). (In Japanese).

The optimum design point of a fast reactor can be obtained only through a theoretical optimization process, because the complexity of the reactor and lack of accumulated experience in design and construction makes it difficult to optimize the design by experience or by intuition. While the nonlinear programming technique would appear suitable for carrying out this optimization process, it is not easy to decide which algorithm should be adopted among the many that could be chosen and which differ largely from each other in characteristics. The various algorithms are compared on the basis of results obtained from numerical experiments. A "Fast Reactor Design Optimization System" is devised, based on a "Method of Approximated Programming" selected as the most suitable one. (auth)

Kinetics and Dynamics

Refer also to abstract 14553.

14469 (BAW–3647-23) PHYSICS VERIFICATION PROGRAM. PART III, TASKS 5 AND 7. Quarterly Technical Report, July–September 1971. Baldwin, M. N. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Dec 1971. Contract AT(30-1)-3647. 41p. Dep. NTIS.

An experimental task to correlate the response of all-solid, self-powered, incore neutron flux detectors to power density profiles of a critical assembly is described. The experimental assembly, a water-moderated, slightly enriched, UO_2 lattice perturbed by Ag–In–Cd poison pins and dissolved boric acid, is arranged to mock up fuel elements of a commercial pressurized water reactor. Results obtained during the third calendar quarter are presented. They will serve to check analytical techniques for relating detector signals and power profiles in commercial power reactors. Also described is a second experimental task utilizing the same basic core lattice to obtain measurements of the effect of B_4C rods on the reactivity and power distribution of the assembly. Except for the B_4C poison rods, these lattice loadings are identical to cores similarly mapped and reported earlier. Since the earlier loadings were perturbed by Ag–In–Cd poison rods, a direct comparison of the two commonly used control rod materials, B_4C and Ag–In–Cd, is available. (7 references) (auth)

14470 (JAERI-M–4467) SOME NUCLEAR DESIGN CALCULATIONS OF EXPERIMENTAL HIGH-TEMPERATURE GAS-COOLED REACTOR PRELIMINARILY DESIGNED FOR MULTI-PURPOSE USE. Yasukawa, Shigeru; Shindo, Ryuichi; Hirano, Mitsumasa; Aruga, Takeo; Makino, M. (Japan Atomic Energy Research Inst., Tokyo). Jun 1971. 118p. (In Japanese).

Some nuclear design calculations of the experimental high-temperature gas-cooled reactor preliminarily designed for multi-purpose use are explained on the following items: neutronic characteristics of unit fuel lattice; fuel management and core burnup performances; axial fuel temperature distribution and its variation with fuel burnup; estimation of control rod worth; and reactivity coefficients and neutron dynamics parameters. (auth) (Japan)

14471 (NP–tr–1940) NUCLEAR DATA REQUIREMENTS FOR THE CALCULATION OF FAST REACTORS. Zaritskii, S. M.; Nikolaev, M. N.; Troyanov, M. F. Translation of Russian article. 10p. (INDC(CCP)–17/U). Dep. NTIS (U. S. Sales Only).

Because of the need for accuracy in calculating the doubling time (±10%), K_{eff} (±1%) and breeding ratio (±2%) of large plutonium breeders, accuracy requirements were formulated for such evaluated nuclear data used in compiling group constants as σ_f for ^{235}U, ν_f for ^{252}Cf, α for ^{239}Pu, the cross-section ratios $\sigma_c^j/\sigma_f^{235}$, $\sigma_i^j/\sigma_f^{235}$, the cross-section for inelastic removal below the fission threshold of ^{238}U, etc. (auth)

14472 PHYSICS EXPERIMENTS IN A PuO_2–UO_2 MICROLATTICE FOR THE DESIGN OF FUEL ELEMENTS IN LWRs. Gibello, A.; Orestano, F. V.; Pistella, F.; Santandrea, E. (CNEN, Casaccia, Italy). J. Nucl. Energy; 25: No. 12, 623-5(Dec 1971).

Experiments performed in a plutonium-fueled microlattice at CSN Casaccia are described. These are of interest for the physics design of plutonium bearing fuel elements. The calculation methods developed were exhaustively tested for their applicability to plutonium-fueled cores in cold, unirradiated conditions. (auth) (UK)

Control Systems

14473 (EUR-4715) CORRELATION METHODS AND ADAPTIVE CONTROL SYSTEM. (COMPARISON, TENDENCIES, AND APPLICATION IN NUCLEAR POWER PLANTS). Ditterich, K. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1971. 19p. (In German). Dep. NTIS (U. S. Sales Only). EUR DM 3,-.

For system analysis two different methods are possible in general, the correlation of stochastic in- and output functions, and the "classic" method by means of differential equations. In practice the correlation technique has some advantages especially in view of automatic processes and adaptive control systems. A rough sketch shows the use of correlation measurements for the process control of a nuclear power plant. 14 references. (auth)

14474 (KFK-EXT-22/71-1) PIN MONITORING IN SODIUM-COOLED REACTORS BY MEANS OF DELAYED NEUTRON DETECTION. Jacobi, S.; Schmitz, G. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Feb 1971. 15p. (In German). INIS.

In sodium cooled reactors pin failures of great extent are able to disturb the running. Pin failures of small extent are tolerable but their behavior has to be surveyed. For the manufacturer of pins they are interesting in order to improve the manufacturing process. The necessity of detecting a damage requires the installation of a plant surveying the pins. Among the different possible methods, detection by delayed neutrons is examined. Experiments are prepared for the KNK I and the KNK II which have to lead to a matured construction for the SNR. For these three reactors the neutron activity concentrations, the resulting impulse rates, and as final result the smallest detectable free fuel surface are calculated. The values of these smallest surfaces are between 0.2 and 2 cm^2. Diagrams show the influence of the transit time from pile to monitor on the neutron activity concentration. (INIS)

14475 ABSORBER DRIVE FOR EMERGENCY SHUT-DOWN OF STEAM OR GAS COOLED REACTORS. Aacher, Heinz (to Licentia Patent-Verwaltungs GmbH). German Patent 1,300,176. 31 Jul 1969. Filed 1 Sep 1967. (In German).

A control mechanism for control rods is described. The drive mechanism plays the role of a piston being displaced at the interior of a fixed tube acting as the cylinder. The fixed tube is placed at the exterior of the pressure vessel of the reactor and penetrates the wall of the pressure vessel in an air-tight manner. (tr-auth)

14476 SELF-POWERED SENSOR FOR MEASURING NEUTRON FLUX IN POWER REACTORS. Babulevich, E. N.; Belavin, M. Yu.; Grishanin, E. I.; (and others). At. Energ. (USSR); 31: No. 5, 465-6(Nov 1971). (In Russian).

The performance of self-powered sensors (SPS) in high temperature nuclear reactors is analyzed. SPS are shown to meet the majority of requirements to incore sensors of a neutron flux density distribution monitoring system. This distribution is a good approximation of the energy generation distribution. Using an analog computer, the measuring channel time constant can be reduced to the value of about 1 sec. The lower sensitivity limit of the SPS is determined mainly by measuring device characteristics, and the higher performance limit is imposed by permissible SPS emitter material burn out. The theoretical and experimental results for power and research reactors are presented. (9 references) (auth)

14477 CHARACTERISTICS OF CONTROL SYSTEMS FOR NUCLEAR TURBINES. Kashiwahara, Katsuto; Taki, Takamitsu (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron; 53: No. 6, 535-41(Jun 1971). (In Japanese).

In turbines for BWR type nuclear power generation, since the turbines are directly rotated by reactor-generated steam, there is a big problem of how to hold the steam pressure at a constant value, because effect of the pressure on reactivity is positive, and pressure rise leads to increase of reactor output. Steam pressure control system contributes to solve the problem. It is divided into two systems of electro-hydraulic and mechanical-hydraulic pressure regulators, the former senses the pressure in main steam pipes before main steam stop valves. Pressure is regulated by controlling regulating valves with the electro-hydraulic pressure regulator as main, and the mechanical-hydraulic pressure regulator as back-up regulators. Signal from governors is combined with the above system, and overall control is well performed. Automatic and remote control of operation are adopted together with radiation protection for operators. (Japan)

14478 NUCLEAR REACTOR PLANT. Allen, David Graham (to British Nuclear Design and Construction Ltd.). British Patent 1,257,642. 22 Dec 1971. Filed 16 Jan 1968.

Reference is made to the control of nuclear power plants of the type wherein heat energy is transferred from the coolant to a working fluid through heat exchangers and the working fluid is used to drive a turbogenerator and is thence returned to the heat exchangers. In the system described changes in power output are initiated by adjusting the rate of flow of the working fluid through the heat exchangers by an amount related to the difference between the actual and required power outputs, adjusting the rate of coolant flow through the reactor so as to regulate the temperature of the coolant leaving the heat exchanger to a predetermined value related to the required power output, and adjusting the input pressure of the working fluid to the turbogenerator to a predetermined value that is also related to the required power output. The control means are electrically operated. Control means may be incorporated for the return flow of used working fluid to the heat exchanger, and the electrical circuits may include means for compensation in grid frequency. (UK)

14479 SYSTEMATIC PROCEDURE FOR REACTOR CONTROL SYSTEM DESIGN. Chang, Sen-I. (Inst. of Nuclear Energy Research, Taiwan); Kerlin, T. W. Nucl. Technol.; 13: No. 3, 241-9(Mar 1972).

A systematic design procedure was developed to aid in the reduction of trial and error in the design of reactor control systems. The method developed uses an automatic optimization to help the designer find the best controller structure and the best controller settings to use in a control system based on conventional controllers (derivative, proportional or integral). The method was demonstrated in a control system design for a Molten-Salt Breeder Reactor. The application of the method gave excellent results at only a modest expense in computer time (five minutes on the IBM-360 Model 91). The method appears to be suitable for routine application in reactor control system design. (8 references) (auth)

14480 TRIAL MANUFACTURE OF CONTROL RODS AND CONTROL ROD DRIVE MECHANISMS AND THEIR EXAMINATION. Seki, Yoshinobu (Mitsubishi Atomic Power Industries Inc., Tokyo); Shiratori, K. Karyoku Hatsuden; 22: No. 2. 163-70 (Feb 1971). (In Japanese).

Control rod drive mechanism of PWRs is one of those which fall behind in domestic production. Trial production and examinations for each new type of the control rod drive mechanism are described. High reliability of the domestically made control rod drive mechanism was ascertained. Materials for a trial product were domestically made except those used for driving coils. Examination was done under similar condition to reactors in operation. In normal temperature examination, load-current test, step length and load transfer length test and scram test were included. The mechanism was ascertained to have enough capacity for rated load. Step length and load transfer length were measured on overall length of a driving shaft, and were satisfactorily within design tolerance. Scram delay time was measured in the scram test, and was within design value. After 40 thousand steps at the normal temperature, 1,100 thousand steps were assigned under high temperature and high pressure condition. After the test, the control rod drive mechanism was disassembled. All parts including springs and sliding faces were in satisfactory condition. The scram delay time measured at the high temperature was also within design value. (Japan)

Shielding

14481 (ORNL-TM-3666) FAST REACTOR SHIELDING, ACTIVITY NO. 40 01 61, 189A NO. 10028. Monthly Progress Report, November 1971. Mynatt, F. R.; Clifford, C. E.; Gritzner, M. L.; Maerker, R. E. (Oak Ridge National Lab., Tenn.). 31 Dec 1971. 36p. Dep. NTIS.

FAST TEST REACTOR — neutron flux in cavity area of, effects of stored fuel elements on, (T)
LIQUID METAL FAST BREEDER REACTOR — coolant for, neutron shielding effects of sodium, (E/T)
NEUTRONS — attenuation in liquid sodium, (E/T)
SODIUM — neutron attenuation in, (E/T)
TOWER SHIELDING FACILITY — pipe chase mockup in, analysis of neutron streaming in, (T) (H.D.R.)

Cooling Systems

Refer also to abstracts 11928, 11946, and 11947.

14482 (RDT-A-1-1-T(10-71)) COOLANT COMPOSITION IN PRESSURIZED WATER REACTORS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1971. 9p. RSO.

Reactor coolant specifications for pressurized water reactors are presented. Impurity limits for makeup water and reactor coolant during normal operation and special plant conditions are specified. The use of chemical additives for pH control, reactivity control and suppression of radiolytic decomposition of reactor coolant is discussed and system design criteria are presented. (auth)

14483 (RDT-E-4-1-T(12-71)) STEAM GENERATOR FOR PRESSURIZED WATER REACTORS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Dec 1971. 36p. RSO.

Construction and acceptance requirements of a pressurized water heated generator for nuclear power plants are presented. (auth)

14484 (WCAP-7803) BEHAVIOR OF AUSTENITIC STAINLESS STEEL IN POST HYPOTHETICAL LOSS OF COOLANT ENVIRONMENT. Whyte, D. D.; Picone, L. F. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 47p.

The performance of austenitic stainless steel in the post hypothetical design basis accident (DBA) environment is evaluated. A detailed review of potentially obnoxious elements was performed and extensive laboratory testing was carried out for elements which available literature indicated a need for additional information. Stressed and unstressed specimens of 304 and 316 stainless steel, both sensitized and unsensitized, were exposed in solution to conditions conservatively simulating those anticipated in the emergency core cooling system following the hypothetical design basis accident. Tests were conducted with added chloride and fluoride contaminants. 15 references. (auth)

14485 REACTOR PURGE SYSTEM. Dyke, T. W.; Hall, M. S. (to Canadian General Electric Co. Ltd.). Canadian Patent 882,393. 28 Sep 1971.

In commissioning a nuclear reactor that is cooled by heavy water, the system oxygen content is initially diminished by purging with CO_2. To remove the CO_2, a purge of helium is used. (F.S.A.) (Canada)

14486 IMPROVEMENTS IN OR RELATING TO COOLANT SYSTEMS FOR NUCLEAR REACTORS. Gratton, Charles Peter (to United Kingdom Atomic Energy Authority). British Patent 1,256,702. 15 Dec 1971. Filed 7 Feb 1968.

Reference is made to gas cooled reactors and particularly to conditions where the coolant temperature may rise to an extent in excess of that required by the heat utilization plant. In the system described means are provided for raising the gas coolant to an elevated pressure, and parallel flow paths are provided for the high pressure gas, one of which extends through the reactor core and offers a higher impedance to gas flow than the other, the latter bypassing the core and flowing through a path of lower impedence to emerge at a lower temperature than required by the heat utilisation plant. Means are provided for mixing the gas streams to produce a supply of gas at a temperature suited to the plant. The second stream does not suffer the pressure drop undergone by the first stream in passing through the core coolant passages and hence the pumping power for the system is appreciably less than when passing the whole of the coolant through the core. Means may be provided for diverting all the high pressure gas through the high impedance flow path if conditions render this desirable. Application to a fast breeder reactor is described, the low impedance flow path then extending through the blanket of fertile material surrounding the core. Means for raising the coolant to an elevated pressure may comprise a pair of gas circulators, each operating on part of the total flow volume of gas, or the first circulator may raise the total coolant flow to a relatively low pressure suitable for the lower impedance flow path, and the second circulator may raise a part of the total flow to a higher pressure for the higher impedance path. (UK)

14487 COOLANT DISTRIBUTING UNITS FOR NUCLEAR REACTORS. Ebeling, Douglas Roy (to United Kingdom Atomic Energy Authority). British Patent 1,257,183. 15 Dec 1971. Filed 6 Sep 1968.

The unit described comprises a pressure vessel acting as a hydraulic accumulator and having a number of manifolds connected to a common supply header having a branch pipe that forms a dip pipe for the accumulator. Supply and delivery pipe connections extend through the wall of the pressure vessel for the header and manifold. The manifolds may take the form of multi-outlet port valves. In use coolant is fed to fuel containing tubes by circulators by way of the header and the manifolds, each manifold serving a group of tubes. The pressure vessel is partly filled with coolant by way of the dip pipe, the pressure at the free surface within the vessel being approximately equal to that of the coolant circuit. In the event of loss of coolant supply from the circulator a continuous supply of coolant to the tubes is maintained by way of the dip pipe until the supply in the pressure vessel is exhausted, by which time emergency measures to shut down the reactor can be brought into operation. As the internal and external pressures of the manifolds and header are substantially equal, the risk of a breach of these components is negligible, and the pressure vessel can be designed with a large margin of safety to withstand the coolant circuit pressure. (UK)

14488 BOILING REACTOR WITH COMPLETELY INTEGRATED CIRCULATING PUMPS OPERATED BY STEAM. Miss, Rolf Woeltje. German Patent 1,564,355. 25 Sep 1969. Filed 22 Sep 1966. (In German).

A boiling reactor with circulating pumps driven by its own steam is described. The control of an individual pump is arranged on a common axis placed perpendicularly to each face of the surface of the water of the moderator. (tr-auth)

14489 NUCLEAR REACTOR COOLANT RECIRCULATION SYSTEM. Townsend, Harold E. (to General Electric Co.). U. S. Patent 3,621,926. 23 Nov 1971. Filed 13 Feb 1968.

A feedwater augmented jet pump coolant recirculation system for nuclear reactors is disclosed. In this system feedwater is used to drive some of the jet pumps. The majority of the jet pumps are operated at constant flow, while flow control is provided by varying the flow of another part of the feedwater between a feedwater sparger within the pressure vessel and the remaining pumps. (Official Gazette)

Fuels

Refer also to abstract 11891.

14490 (GEAP-13731) MEASURED LOSS OF SELECTED FISSION PRODUCTS FROM HIGH-BURNUP MIXED-OXIDE FUEL IN A MINIATURE PUMPED SODIUM LOOP. Plumlee, D. E.; Novak, P. E. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Aug 1971. Contract AT(04-3)-189. 32p. Dep. NTIS.

A defected section of mixed-oxide fuel preirradiated to ~41,000 MWd/Te was exposed to ~1150°F flowing sodium for 18 hours in a miniature pumped loop in a hot cell. Fuel pin diametral increase and the transfer of fuel and fission product species from the fuel specimen to different portions of the loop were measured, to provide an improved design basis for the accommodation of failed fuel in LMFBR systems. Post-test examination of the fuel specimen showed: an ~3% increase in the average diameter of the fuel section, less than 1% loss of fuel from the specimen with uranium preferentially leached compared with plutonium, and substantial loss of fuel specimen fission products ranging from 29 to 85% for the isotopes investigated. Post-test examination of the loop indicated plate-out of fission products in the colder regions, with the exception of Cs which remained in solution in the sodium. (8 references) (auth)

14491 (JAERI-M-4413) ESTIMATION OF NUCLEAR FUEL DEMAND AND POWER REACTOR CONSTITUTION IN NUCLEAR POWER GENERATING SYSTEM. Yasukawa, Shigeru; Furuhashi, Akira (Japan Atomic Energy Research Inst., Tokyo). Apr 1971. 47p. (In Japanese).

The evaluation of nuclear fuel demands and of power reactor constitution in the nuclear power generating system are made by FUEL-DEMAND-II code through the basis of the latest estimation of nuclear power generating capacity. Results of the calculations are presented. (auth) (Japan)

14492 (JUL-792-RG) INVESTIGATIONS ON THE ECONOMY OF THERMIONIC FUEL ELEMENTS IN HIGH-TEMPERATURE REACTORS. Bonka, H.; Sammeck, K.-H.; Voss, A.; Will, M.; Zoeller, R. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Sep 1971. 44p. (In German). Dep. NTIS (U. S. Sales Only).

Nuclear reactors for space research purposes should be equipped with thermionic fuel elements. In that connection the question was studied if thermionic fuel elements might also be applied for economic electricity generation, because they lead to an increase in the efficiency rate of the total power plant. The computation of a high-temperature reactor of 600 MW(e) showed that for the wanted thermal neutron spectrum at which radiation damage of fuel ele-

ments can be kept possibly low, the parasitic absorption in the structure materials tungsten and niobium will be too high. In order to achieve reactor criticality, a high fission inventory is required. Also, the fabrication cost of thermionic fuel elements will considerably increase the fuel cycle cost. Even under the assumption of a fuel element price of 10 DM per element the fuel cycle cost would amount to 2.7 DPfg/kWh with a load factor of 0.8. 20 references. (auth)

14493 LMFBR FUEL ROD DESIGN LIMITS AND TRANSIENT SURVIVAL CRITERIA. Carelli, Mario D.; Anderson, Carl A. Jr.; Markley, Robert A. Nucl. Eng. Int.; 17: No. 188, 43-7(Jan 1972).

The design limits and the transient survival criteria of typical fuel elements for large Liquid Metal Fast Breeder Reactors are quantitatively analyzed. An extensive review of the limiting conditions, i.e., essentially maximum allowable cladding fuel temperatures, and tolerable amount of molten fuel, which are currently assumed by reactor designers, indicates that such conditions are very conservative with respect to the expected failure limits. (auth) (UK)

14494 FAST REACTOR FUEL TESTING PROGRAM. Uematsu, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 17: No. 3, 37-42(Mar 1971). (In Japanese).

Since fast reactor fuel is much different from thermal neutron reactor fuel, experience in thermal neutron reactors can not be adapted directly to the fast reactor fuel. Power Reactor and Nuclear Fuel Development Corporation of Japan plans to practice minimum necessary irradiation test of fuel in overseas reactors until tests in domestic reactors will be available in order to develop the fast reactor fuel in Japan. Though post-irradiation examination of fuel under irradiation at present will also depend on overseas facilities, the Corporation has a program to utilize a fast experimental reactor as an irradiation facility for nuclear fuel and materials in future. The Corporation is building and equipping the facilities to perform the post-irradiation tests independently. Irradiation tests and planned future irradiation program schedules for the development of fast reactor fuel are shown. (Japan)

14495 FUEL ELEMENTS OF GRAPHITE-GAS REACTORS. Boudouresques, Bernard (CEN de Saclay, Gif-sur-Yvette, France). Ind. At.; 15: No. 4, 17-24(Sep 1971). (In French).

A new fuel element was developed in order to increase the performance of graphite–gas reactors. It consists of a fuel tube constructed of a uranium alloy of low absorption, and a graphite core. It is compared with the standard element currently used in Chinon 2, Chinon 3, and St. Laurent I. Improvements are observed in the level of combustion and the working temperatures. The possibility of a burst slug is examined in detail. (France)

Auxiliary and Emergency Systems

14496 EMERGENCY FEED SYSTEMS. Appleby, John Rand; George, Brian Victor (to British Nuclear Design and Construction Ltd.). British Patent 1,258,046. 22 Dec 1971. Filed 2 Jan 1968.

Reference is made to emergency feed systems for power plants that includes at least two boilers, and the system described is stated to be applicable to nuclear power plants comprising a number of reactors each having one or more associated boilers. Disadvantages of systems hitherto used are briefly mentioned. The system described comprises at least one emergency feed pump connected into a common feed line for the boilers, with valves associated with each boiler, the arrangement being such that each valve operates, when emergency feed is required to its boiler, to reduce the feed pressure of the boiler to a predetermined value lower than the lowest pressure at which the boilers normally operate or are started up. (UK)

14497 DEVICE FOR PURIFYING A GAS CONTAINING OXIDIZABLE IMPURITIES, SUCH AS THE COOLING GAS OF A GRAPHITE MODERATED NUCLEAR REACTOR. Zermizoglou, Roger (to Commissariat a l'Energie Atomique). French Patent 2,061,573. 25 Jun 1971. Filed 25 Jul 1969. (In French).

The purification of the CO_2 coolant of nuclear reactors is discussed. The CO_2 contains oxides of C and H, and possibly oxygen. The CO_2 is combusted over a catalyst at a sufficiently high temperature to eliminate the hydrogen and some of the CO and oxygen. The steam, which is subsequently formed, is eliminated by circulating the gas over two catalysts, whose active elements have high activities in relation to the combustion of the hydrogen and CO respectively. (FRANCE)

Operation and Economics

14498 (PEL–210) PELINOMIC II: A COMPUTER PROGRAMME FOR CALCULATING NUCLEAR POWER COST. Maunders, E. J.; Ernst, A. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Aug 1971. 11p. Dep. NTIS (U. S. Sales Only).

PELINOMIC II is a computer program which is primarily designed for detailed calculations on the cost of power from natural or enriched U-burning thermal reactors. It is one of a series of programs being developed for the purpose of facilitating the evaluation of tenders for nuclear power reactors from commercial organizations. It is well known that the use of simplified techniques, such as the extended equilibrium model, can lead to errors of over 20% in the present-worthed, life-time-averaged fuel cycle cost for enriched U systems, due to the complexity of fuel cycle operations and the varying fuel requirements during the "approach to equilibrium" period. Accordingly, this program was written in such a way as to eliminate these errors as far as possible and to consider, further, such details as the cost of transport and insurance associated with the various phases of the nuclear fuel cycle, material losses during fuel manufacture, and the contractural requirements appropriate to the purchasing of fuel for a power reactor as well as the varying financing details associated with purchasing the reactor itself. The user has the freedom to compare vendors' fuel cycle costs, with a load factor derived from system studies rather than one assumed to be constant, as is commonly done. The language used is FORTRAN 4G. (auth)

14499 (PEL–211–E) ADVANCED REACTOR TYPES OF POTENTIAL FUTURE INTEREST TO SOUTH AFRICA. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Aug 1971. 44p. Dep. NTIS (U. S. Sales Only).

The most important reactor development projects underway in several countries are reviewed in relation to South African conditions and future requirements. Reactor types include high temperature gas-cooled reactors, sodium-cooled and gas-cooled fast breeder reactors, and molten salt reactors. 38 references. (H.D.R.)

14500 OPERATIONAL EXPERIENCE OF THE AVR REACTOR JUELICH. Cautius, W. Energiewirt. Tagesfragen; 20: No. 6, 312-14(1970). (In German).

The availability and the disturbances in the years 1968 and 1969 are given. The behavior of spheres with regard to impact stability, oxydation stability, and fission gas release is considered. All possible disturbances were investigated. The starting processes and the charging program are discussed. (INIS)

14501 PROCEDURE FOR THE OPERATION OF A NUCLEAR REACTOR AND NUCLEAR REACTOR FOR CARRYING OUT THE METHOD. Nichols, Ronald William (to Atomic Power Constructions Ltd.). German Patent 1,811,587. 31 Jul 1969. Filed 29 Nov 1968. (In German).

A procedure for the operation of a nuclear reactor of the integral gas-cooled, graphite-moderated type with at least one primary heat exchanger within the pressure vessel is described. The primary heat exchanger transfers the heat from the reactor coolant gas to a secondary coolant operating a turbine. At least one secondary heat exchanger is also placed within the pressure vessel for heat removal from the reactor coolant during abnormal operating conditions. (tr-auth)

Safety and Siting

14502 (ORNL–4752) EFFECT OF LIGHT-WATER REACTOR FUEL ROD FAILURE ON THE AREA AVAILABLE FOR EMERGENCY COOLANT FLOW FOLLOWING A LOSS-OF-COOLANT ACCIDENT. Rittenhouse, P. L.; Hobson, D. O.; Waddell, R. D. Jr. (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 73p. Dep. NTIS.

A series of temperature transient burst tests were performed on bundles of simulated light-water reactor fuel rods. The experiments were conducted with rod internal pressures ranging from 100 to 1200 psig and heating rates from 10 to 100°F/sec. The major intent of this program was to ascertain the degree of coolant channel blockage that would be provided by fuel rod deformation and rupture during the loss-of-coolant accident postulated for light-water reactor systems. The blockages measured in our multirod experiments were somewhat lower than those which can be predicted on the basis of swelling data for Zircaloy cladding tubes. This result is explainable in terms of interference between simultaneously deforming adjacent rods, some randomness of the axial position of maximum deformation and rupture, and test configuration. Criteria, related primarily to fuel rod internal pressure, are proposed for analysis and prediction of

blockages produced in the reactor core by deformation of the fuel rods. Depending on reactor operating history and conditions and the severity of the loss-of-coolant accident, coolant channel blockages could range from essentially zero in some cases to almost 100% over appreciable portions of the core in others. (auth)

14503 (ORNL–4758) EMBRITTLEMENT OF ZIRCALOY-CLAD FUEL RODS BY STEAM DURING LOCA TRANSIENTS. Hobson, D. O.; Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 49p. Dep. NTIS.

One of the possible consequences of a loss-of-coolant accident (LOCA) in a light-water reactor would be the rapid heatup of the fuel tubes in a steam environment. During the period of time in which the cladding was exposed to steam (provided both from boil-off of residual water in the pressure vessel and by the emergency coolant) at elevated temperatures, reaction of the Zircaloy with the steam would cause the formation of an oxide film on the cladding surface and an oxygen gradient into the wall. Since the ductility of Zircaloy is a direct function of oxygen content, and since the oxygen content is a function of time and temperature of steam exposure, a study of the degree of embrittlement to be expected in a LOCA necessitates the examination of specimens exposed to specific temperatures for given lengths of time in a steam environment. Correlations are developed among steam exposure, oxygen content, ductility, and hardness which permit estimating the degree of embrittlement the cladding would attain during any LOCA transient. Curve fitting to LOCA transient data and subsequent integration provide easy analysis of the amount of embrittlement expected. (auth)

14504 (ORNL-TM-3623) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR SEPTEMBER–OCTOBER 1971. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 156p. Dep. NTIS.

The accomplishments during the months of September and October in the research and development program are summarized. Much of this work is in general support of water-cooled power reactor technology, including LOFT and industry programs, and reflects current safety problems, such as blowdown heat transfer studies. Several projects are also conducted in support of the high-temperature gas-cooled reactor (HTGR) and the liquid-metal fast breeder reactor (LMFBR) programs. Other major projects are those on primary piping and steel pressure-vessel technology. They also include experimental investigations of the attachment of nozzles to shells and the implementation of joint AEC-PVRC programs on heavy-section steel technology and nuclear piping, pumps, and valves. Seismic considerations of particular significance in nuclear plant design are evaluated in the seismic program. Several of the above projects are also directly related to another major undertaking, the AEC's standards program, which entails development of engineering safeguards and the establishment of codes and standards for government-owned or -sponsored reactor facilities. The recent activities of NSIC and the Nuclear Safety journal in behalf of the nuclear community are also discussed. Of particular interest in both of these activities is the recent emphasis on environmental effects. (auth)

14505 (WCAP–7588(Rev.1)) EVALUATION OF THE ROD EJECTION ACCIDENT IN WESTINGHOUSE PRESSURIZED WATER REACTORS USING SPATIAL KINETICS METHODS. Risher, D. H. Jr. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 121p.

The consequences of a rod ejection accident are investigated in relation to the latest, high power density pressurized-water reactors. Limiting criteria are presented, based on experimental evidence, and if not exceeded these criteria will ensure that there will be no interference with core cooling capability and radiation releases, if any, will be within the guidelines. A basis is presented for the conservative selection of plant parameters to be used in the analysis, such that the analysis is applicable to a wide range of past, present, and future reactors. The calculational method employs a one-dimensional spatial kinetics computer code and a transient fuel heat transfer computer code to determine the hot spot fuel temperature versus time following a rod ejection. Using these computer codes, the most limiting hot channel factor (which does not cause the fuel damage limit criteria to be exceeded) has been determined as a function of the ejected rod worth. By this means, the limit criteria have been translated into ejected rod worths and hot channel factors which can be used effectively by the nuclear designer and safety analyst. The calculational method is shown to be conservative, compared to the results of a three-dimensional spatial kinetics analysis. 14 references. (auth)

14506 (WCAP–7826) INVESTIGATION OF CHEMICAL ADDITIVES FOR REACTOR CONTAINMENT SPRAYS. Bell, M. J.; Bulkowski, J. E.; Picone, L. F. (Westinghouse Electric Corp., Pittsburgh, Pa.). Dec 1971. 80p.

A study was conducted to evaluate certain chemical additives for use in a reactor containment spray to enhance the removal of fission product iodine sodium thiosulfate in boric acid solution, sodium thiosulfate in alkaline boric acid solution, and alkaline boric acid solution alone, were each evaluated. Laboratory tests consisted of thermal stability studies of the conditions following a hypothetical loss of coolant accident, studies of radiation stability and radiolysis of the aqueous solutions, chemical reactions between the additives and iodine, and evaluations of the corrosiveness of the spray additive solution toward plant materials. 11 references. (auth)

14507 EFFECTS IN RHINE RIVER OF THERMAL EFFLUENTS FROM NUCLEAR POWER PLANTS. INTERNATIONAL LAW ASPECTS. Fischerhof, H. Energiewirt. Tagesfragen; 21: No. 2, 101-10(1971). (In German).

Nuclear power plants sited at international waters are of topical interest with regard to international law owing to the problem of the waters' loading capacity with hot water. The problems of coolant water discharge are briefly discussed and some technical-physical elaborations (FRG, France, Switzerland) are mentioned. The Helsinki Rules (International Law Association, Water Law Committee: Helsinki Rules on the Uses of Waters of International Rivers, Helsinki 1966) are discussed in detail. Examples of bilateral and multilateral international agreements on protection against pollution and on the maintenance of both mutual and diverging interests in water uses are compared juridically. (INIS)

14508 INDIVIDUAL DOSIMETRIC CONTROL AROUND REACTORS. Chechetkin, Yu. V.; Kobzar, I. G.; Kotikov, P. I.; Moshkin, V. D. At. Energ. (USSR); 31: No. 5, 532-3(Nov 1971). (In Russian).

For three different reactors the extent of exposure by reactor operators to β-radiation of three energy ranges was analyzed for three areas: the skin, subcutaneous tissue, and the crystalline lens of the eye. For the same three reactors the radiation doses to personnel in 1967, 1968, and 1969 are analyzed with beta, gamma, and thermal neutron exposure data tabulated separately. In consideration of the insignificant average yearly radiation exposure of reactor personnel, and the near-absence of radiation hazards in jobs such as administration, it is suggested that the period of wearing individual dosimeters be increased to two months. (K.S.W.)

14509 SODIUM-WATER REACTION IN STEAM GENERATORS. Hori, Masao (Power Reactor and Nuclear Fuel Development Corp., Oarai, Japan). Genshiryoku Kogyo; 17: No. 8, 43-7 (Aug 1971). (In Japanese).

Steam generators used for prototype fast breeder reactors employ single wall structure between sodium and water. There are provisions designed to prevent loss of safety and economy in case of accident of sodium–water reaction caused by water leakage. Various provisions taken against large leakage accidents and small leakage accidents involving water are described. (Japan)

14510 ANALYSIS OF ACCIDENT IN FAST REACTORS MELT-DOWN. Nakamura, Kunihiko (Kyoto Univ., Uji, Japan). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 32, 1-13(Feb 1971). (In Japanese).

A melt-down accident was analyzed with the Bethe–Tait model. It was assumed that spatial distribution of power density is time-invariant during run-away, and density change in the fusing core and propagation of pressure waves are negligible. The distribution of power density and importance distribution were approximated with parabolic curves. Relation between pressure and generated energy was approximated to be linear. The output run-away was considered by division into two regions. Emitted energy was investigated with an equation of dynamic characteristics of the core, taking reactivity change into consideration. The reactivity input was the most controlling factor for the accident. Numerical analysis was carried out with the equations of dynamic characteristics, equation of motion of fusing material, equation of continuity, state equation, equation for specific heat, equation of energy balance, equation of Doppler feed back and equation expressing feed back due to disassembly. Code AX-1 was used for the analysis. Difference between the calculation with the code AX-1 and by the perturbation method of the Bethe–Tait model was observed in change of total energy for stepped input. Effect on density change due to the disassembly was studied. Effects of Doppler coefficient on peak power, the total en-

ergy, and maximum temperature at core center were also shown. (Japan)

14511 SIMPLE MODEL FOR THE ESTIMATION OF AEROSOL CONCENTRATION IN A CLOSED VESSEL. Davis, R. J. (Oak Ridge National Lab., Tenn.). Amer. Ind. Hyg. Ass. J.; 32: No. 9, 603-9(Sep 1971).

A computer code was developed which calculates airborne concentration of an aerosol as a function of time. Particle generation, coagulation, and settling are the mechanisms included. The simplicity is achieved largely by use of a postulated steady-state size distribution function. Calculated and observed concentration versus time are shown to agree quite well. A series of calculations of concentration versus time are presented to show the effects of various parameters. 10 references. (auth)

Power Conversion Systems

14512 (CONF-710935-4) FAST VALVING AS AN AID TO POWER SYSTEM TRANSIENT STABILITY AND PROMPT RE-SYNCHRONIZATION AND RAPID RELOAD AFTER FULL LOAD REJECTION. Paper No. 71 TP 705-PWR. Cushing, E. W. Jr. (Montaup Electric Co., Fall River, Mass.); Drechsler, G. E.; Killgoar, W. P.; Marshall, H. G.; Stewart, H. R. 11 Jun 1971. 12p. IEEE, New York $1.35.

From Joint power generation conference; St. Louis, Mo. (19 Sep 1971).

As steam turbine generator units increase in rating, their inertia constants tend to decrease and their reactance constants to increase, thus aggravating the power system transient stability problem. There is also a tendency for the complete unit to take longer to restart and reload when unscheduled disconnection from the system takes place. Countermeasures are needed and may be available within the power plant. A study of these measures is described. 17 references. (auth)

14513 PROFILE OF NUCLEAR POWER STATIONS BLOCKS. Anan'ev, E. P.; Kruzhilin, G. N. At. Energ. (USSR); 31: No. 5, 443-7(Nov 1971). (In Russian).

The problem of reliability of large nuclear power stations elements, the main factor which influences economic indices of nuclear power stations as well as on economics of energy supply, is examined. A nuclear power station with powerful reactor in a block with turbogenerators is considered. The problems of strength, reservation of automatic systems of reactor control, circulating loops and turbogenerators are analyzed. The turbogenerator as a more complex system from a dynamic point of view than the reactor is described. The choice of single power and speed of turbine rotation (3000 or 1500 rotations per minute) is itself an interesting independent problem. It is shown that for a nuclear power station of large capacity it is reasonable to use two turbines per reactor. (auth)

Research and Test Reactors

Refer also to abstracts 12181, 14081, 14452, 14559, and 14573.

14514 (AWRE-O-72/71) DESCRIPTION OF THE RESEARCH REACTOR HERALD. Hindley, D. (Atomic Weapons Research Establishment, Aldermaston (England)). Dec 1971. 46p. Dep. NTIS (U. S. Sales Only). UK 60p.

HERALD is a light water moderated and cooled reactor operated at power levels up to 5 MW and used for neutron beam research, materials testing and small scale radioisotope production. The reactor is described in sections: location of the reactor, general description, reactor core, fuel elements, reflector elements, lead elements, lattice plate, locking grids, control absorbers, control rods, core box and support, reactor tank, cooling water outlet pipe, thermal shield and biological shield, beam tubes and thermal column, reactor top gantry, cooling water system, core emergency spray, ventilating system, reactor hall crane, instrumentation, cooling water temperature rise, cooling water inlet temperature, nitrogen-16 monitors, cooling water flow meters, neutron shutdown amplifiers, neutron doubling-time amplifiers, neutron linear amplifier and automatic control, safety, interlock and control circuits, depth of water in reactor tank, fission product detection, emergency evacuation alarms, control rod clutch release and rod drop timers and ancillary instrumentation. (UK)

14515 (CONF-710402-(Vol.1), pp 17-21) SMALL RESEARCH REACTORS: NEUTRONS FOR THE DEVELOPING WORLD. Spinrad, Bernard I. (Argonne National Lab., Ill.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The applications of small research reactors for irradiation programs and radioisotope production are reviewed. (D.C.C.)

14516 (CONF-710402-(Vol.1), pp I.5-17) REACTORS FOR NEUTRON APPLICATIONS. Whittemore, William L. (Gulf Energy and Environmental Systems, Inc., San Diego, Calif.). Aug 1971.

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

Reactors have been widely used as sources of neutrons for research and development. Attention by the scientific and engineering community has been devoted to developing the desired research and testing reactors. In addition to special attention received by research reactors with very high power levels (>10 MW) having the largest capabilities, reactors of all sizes and levels of performance have been planned and/or constructed. The large range of reactor capabilities with examples selected from mini-reactors to a 10-MW D_2O research reactor is reviewed. The changing climate for research and development is noted as are the related changes in requirements that are being placed on reactor sources of neutrons. (29 references) (auth)

14517 (EUR-4676) ANALYSIS OF CRITICAL EXPERIMENTS ON THE SORA MOCKUP BY THE S_N METHOD. Asaoka, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jul 1971. 36p. Dep. NTIS (U. S. Sales Only). EUR F.Fr. 5.60.

The results of the analysis of the critical experiment for the pulsed fast reactor SORA by the use of the Carlson S_N method are summarized. Six-group two-dimensional S_4 calculations of the reactivity for measured critical configurations confirm that the criticality of the SORA reactor can be predicted to within about ±1% in the reactivity with the well known cross-sections tested for spherical critical assemblies. An analysis of measurements on the reactivity worth of a control rod or scatterer shows that the two-dimensional S_N code can be used to estimate the worth with a reasonable accuracy in the case where a precise treatment of the three-dimensional geometry is not essential. 20 references. (auth)

14518 (EURFNR-958) INVESTIGATION OF INTEGRAL PARAMETERS OF THE FAST-THERMAL REACTOR STARK, ASSEMBLY 5. Kussmaul, G.; Meister, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Aug 1971. 93p. (KFK-1465). Dep. NTIS (U. S. Sales Only).

Work Performed under United States-Euratom Fast Reactor Exchange Program.

A compilation of zero-power integral experiments carried out in the fast-thermal reactor STARK Assembly 5 is presented. In these experiments the neutron spectrum, reaction rates and material worths in the center of the fast zone as well as physics properties of the entire system were studied. Special emphasis was laid on the further development of the square-wave pile oscillator method to measure reactivity worths of samples. The experimental results are discussed on the basis of standard multigroup calculations, and some conclusions are drawn as to the suitability of different 26-group cross section sets. With the particular fast core composition of this assembly, a central neutron spectrum almost identical with the equilibrium spectrum was obtained, such that reaction rates and the majority of reactivity worth ratios at core center closely represent the values for an all-fast system of the same core composition. 34 references. (auth)

14519 (GEAP-13671) CALCULATED RADIOACTIVITY OF THE FFTF PRIMARY SODIUM SYSTEM DUE TO MASS TRANSFER. Wozadlo, G. P.; Boardman, C. E.; Weiss, M. L. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Aug 1971. Contract AT(04-3)-189. 28p. Dep. NTIS.

The radioactivity deposited in the cooling system of an FFTF by corrosion and mass transport was reestimated. The calculated intensity levels predicted would not permit contact maintenance of key components after 20 years, and only very limited access during the initial year of operation. The most important isotopes are cobalt-60, manganese-54, and cobalt-58. The estimated range of dose rates at a distance of 2 feet from key components after 20 years of FFTF operation is: IHX 5.5 – 130 R/h; cold-leg piping 50–90 R/h; cold trap 0–45 R/h; hot-leg piping <0.5 R/h; primary pump <0.5 R/h. The results are based on current state-of-the-art values and analyses; considerable uncertainty in the calculated results exists. The values stated are believed to be conservative. 16 references. (auth)

14520 (IAEA-R-538-F) ANALYSIS OF IMPURITIES AND THEIR REMOVAL FROM REACTOR COOLING WATER. Final

Report, December 15, 1967–March 14, 1971. Szabo, E.; Csada, G. I.; Ordogh, M.; Ambrus, G.; Nagy, O.; Szabo, J. (International Atomic Energy Agency, Vienna (Austria)). May 1971. 93p. INIS.

The report summarizes the work carried out over three years on the analysis and purification of the primary cooling water circuit of the Hungarian VVR-S reactor. The work done consists of two parts: (1) Radiochemical analysis of the cooling water; and (2) Investigations on the by-pass treatment of the primary cooling water. The radiochemical investigations of the cooling water of the VVR-S reactor were devoted to the determination of some short-lived radioisotopes and, mainly, to long-lived radioisotopes. For these purposes, a technique for adsorption of the contaminants on oxycellulose, as well as paper chromatographic separation technique, was developed. Measurement of the separated radioisotopes was accomplished with the aid of a multi-channel gamma spectrometer. The determination of the long-lived isotopes in the reactor cooling water was made by the activation analysis methods developed for quantitative determination. For the measurement of the low concentrations of uranium the procedure was developed on the basis of the nuclear reaction $^{238}U(n,\gamma)^{239}U \rightarrow {}^{239}Np$. The activity of the iodine-131 was measured by means of extraction technique, as well as with the aid of isotopic exchange technique. The results show the presence of the following short-lived radioisotopes in the cooling water: copper-64, manganese-56, sodium-24. Among the long-lived radioisotopes were: chromium-51, antimony-124, manganese-54, zinc-65, cobalt-60, barium-140 and cesium-137. The iodine-131 content in the reactor water is shown for the period from 1966 to 1969. The quantity of uranium detected has always been less than $5.10^{-5}/\mu g/ml$. On the basis of the above-mentioned results, investigations on the bypass treatment of the primary cooling water in the VVR-S reactor were made. In this context, measurements of specific electrical conductivity, the total iron and aluminum content, and the determination of the variation of the H_2O_2, NO_3^- and NH_3 concentration were made periodically. The variation of the iron, aluminum and ammonia content was found to be relatively small, while the H_2O_2 content showed a definite increase with operation time. The specific electrical conductivity varies between 5.03 and 11.5 $\mu s\ cm^{-1}$. Various KS type cation exchanger and Varion AD type anion exchanger were used both in original and in pulverized form for the purification of the cooling water. It was found that the activities can be removed from the cation exchanger to 67%, from the anion exchanger to 79%, and from a mixed-bed exchanger to 75%. Comparative experiments on Varion KS resin in potassium and hydrogen form have shown that the ion escape probability is essentially the same for both forms of the resin. This means, therefore, that the two forms of Varion KS resin work with the same efficiency. The decontaminating effect of the 5 mm thick mixed layer prepared from pulverized Varion KS and Varion AD was found to be of the order of 10^2 and the possible use of the pulverized ion exchangers in nuclear reactors has thus been shown. (INIS)

14521 (JAERI-M-4386) STABILIZATION OF COOLANT TEMPERATURE BY FLOW RATE VARIATIONS IN CORE OF JEFR. I. Ezaki, Mashiro; Suzuki, Katsuo; Saito, Shinzo (Japan Atomic Energy Research Inst., Tokyo). Mar 1971. 28p. (In Japanese).

The control system of coolant flow variations is useful in measuring transfer functions of nuclear kinetics when neglecting the effect of reactivity feedback of coolant and structures. This measuring technique consists of injecting sinusoidal reactivity into the core, and at the same time controlling the coolant flow rate of the same frequency with phase shift. These are related to each other in such a way that the coolant average temperatures may remain constant. However, the large amplitude of coolant flow rate variation leads the neutron dynamic characteristics to instability. So, coolant flow doesn't cover the high frequency region under the influence of the hydrodynamic characteristics of the coolant flow loop. (auth) (Japan)

14522 (JAERI-M-4453) RESPONSE OF THE INSTRUMENTS FOR THE JMTR FUEL MELTING. INCIDENT-EXAMPLE RESEARCH, SERIES-1. (Japan Atomic Energy Research Inst., Tokyo). May 1971. 21p. (In Japanese).

The response of instruments in the JMTR are studied for a hypothetical melting incident of the fuel element ($^1/_{10}$ of a fuel element melting = 20 grams of U-235) due to a flow blockage. The fraction of fission products released into the coolant water is assumed to be 100%. A fuel melting of this scale sufficiently causes the off-scale in most of the instruments of the JMTR. (auth) (Japan)

14523 (JAERI-M-4471) INVESTIGATION OF THERMAL NEUTRON FLUX ON JRR-4 FLUX-TRAP CORE. Ohnishi, Nobuaki; Kutsukake, Chuzo (Japan Atomic Energy Research Inst., Tokyo). Jun 1971. 16p. (In Japanese).

JPR-4 is being widely used at present for nuclear physics, reactor engineering, radioisotope production, reactor training, and shielding experiments. With increase in irradiation experiments and radioisotope production in recent years there has been a need to increase the thermal neutron flux without extensive reconstruction of the core configuration. Investigation of power-up and flux-trap core has therefore been carried out in the technical aspects. The results of experiments and calculation are presented on the JJR-4 flux-trap core. The flux-trap was obtained in the center of reactor core by substituting light moderator for a fuel element; and the thermal neutron flux distribution was measured by Cu tape irradiation in the flux-trap and a fuel element placed nearest to the flux-trap. From the experiments, the maximum thermal neutron flux was estimated as about 7×10^{13} neutrons/cm^2 sec at 2.5 MW power, and it was also found that the thermal neutron flux distribution had a steep gradient in the nearby fuel elements. (auth) (Japan)

14524 (JAERI-M-4506) OPERATION AND USES OF JRR-1. Suzuki, Kazuhiko; Yamamoto, Akira; Omori, Eiichi; Ikezawa, Yoshio (Japan Atomic Energy Research Inst., Tokyo). Jul 1971. 110p. (In Japanese).

JJR-1 went critical on August 27, 1957 and terminated its operation on November 21, 1969. The administration, technical problems of operation and radiation monitoring, personnel training and experiments are reviewed. (Japan)

14525 (LA-4722) FLUX OPTIMIZATION FOR A KING REACTOR. Adler, Felix T. (Los Alamos Scientific Lab., N. Mex.). Dec 1971. Contract W-7405-eng-36. 11p. Dep. NTIS.

KING-type reactors can be optimized by modifying various design parameters because these reactors are not limited by in-core heat transfer requirements. The maximum thermal flux attainable in a flux trap has been investigated by varying fuel concentrations and flux trap radii in a series of criticality calculations. The performance index of the reactor has a maximum for a flux trap radius of 4.25 cm and, at the optimal radius, the performance index apparently becomes insensitive to increases in fuel concentration above 220 g(^{235}U)/liters. Effects of a central irradiation thimble and adaptations of the KING reactor for use as a fast-flux irradiation facility are discussed briefly. 16 references. (auth)

14526 (RDT-E-13-1-T(6-71)) FAST FLUX TEST FACILITY CERAMIC GRADE PLUTONIUM DIOXIDE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 15p. RSO.

The requirements for PuO_2, ceramic grade, for use in the fabrication of mixed oxide fuel pellets are presented. (auth)

14527 (RDT-E-13-2-T(6-71)) FAST FLUX TEST FACILITY CERAMIC GRADE URANIUM DIOXIDE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 13p. RSO.

The requirements for UO_2, ceramic grade, for the fabrication of mixed oxide fuel pellets and insulator pellets are presented. (auth)

14528 (RDT-E-13-5-T(6-71)) FAST FLUX TEST FACILITY DRIVER FUEL PIN. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 21p. RSO.

The requirements for driver fuel pins for the FFTF are presented. Driver fuel pins consist of PuO_2-UO_2 pellets clad with Type 316 stainless steel. (auth)

14529 (RDT-E-13-6-T(6-71)) FAST FLUX TEST FACILITY DRIVER FUEL PIN FUEL PELLET. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 26p. RSO.

The requirements for mixed PuO_2-UO_2 fuel pellets to be used in the FFTF driver fuel pins are presented. (auth)

14530 (RDT-E-13-7-T(6-71)) FAST FLUX TEST FACILITY DRIVER FUEL PIN INSULATOR PELLET. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 16p. RSO.

The requirements for UO_2 insulator pellets to be used in the FFTF driver fuel pins are presented. (auth)

14531 (RDT-E-13-8-T(6-71)) FAST FLUX TEST FACILITY DRIVER FUEL PIN SEAMLESS CLADDING TUBE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 34p. RSO.

The requirements for 20% cold worked modified Type 316

stainless steel seamless tubes for FFTF driver fuel cladding are presented. (auth)

14532 (RDT-E-13-9-T(6-71)) FAST FLUX TEST FACILITY DRIVER FUEL PIN END CAPS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 21p. RSO.

The requirements for driver fuel pin end caps for the FFTF which are to be made from 20% cold worked modified Type 316 stainless steel rod are presented. (auth)

14533 (RDT-E-13-10-T(6-71)) FAST FLUX TEST FACILITY DRIVER FUEL PIN REFLECTORS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 15p. RSO.

The requirements for Inconel 600 reflectors for use in FFTF driver fuel pins are presented. (auth)

14534 (RDT-E-13-11-T(6-71)) FAST FLUX TEST FACILITY DRIVER FUEL PIN PLENUM SPACER. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 16p. RSO.

The requirements for Type 316 stainless steel plenum spacers for FFTF driver fuel pins are presented. (auth)

14535 (RDT-E-13-12-T(6-71)) FAST FLUX TEST FACILITY DRIVER FUEL PIN PLENUM SPRING. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 15p. RSO.

The requirements for Type 302 stainless steel plenum springs to be used in FFTF driver fuel pins are presented. (auth)

14536 (RDT-E-13-13-T(6-71)) FAST FLUX TEST FACILITY DRIVER FUEL PIN WRAP WIRE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1971. 18p. RSO.

The requirements for 17% cold worked modified Type 316 stainless steel wire for wrapping FFTF driver fuel pins are presented. (auth)

14537 (UJV-2693-R) CALCULATIONS OF THE PHYSICAL CHARACTERISTICS OF THE ACTIVE ZONE OF THE CZECHOSLOVAKIAN EXPERIMENTAL FAST REACTOR ZRR. Chermak, I.; Tinka, I.; Tmitrova, E. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sep 1971. 51p. (In Russian). Dep. NTIS (U. S. Sales Only).

In connection with the efforts on the design of the Czechoslovak experimental fast reactor ZRR, it was necessary to carry out a number of physical calculations which were to serve as a basis for the complete study. The calculational model of the reactor and the choice of basic constants together with the choice of calculation methods are discussed with respect to the complexity of the reactor and with respect to calculating possibilities. Questions of critical mass determination, calculations of space-energy neutron flux distribution in the core and reflectors, isotopic composition during the working of the reactor (burnup), effectiveness of the system of control rods and reactivity coefficients are given. 9 references. (auth)

14538 SEMI-AUTOMATIC SYSTEM FOR ACTIVATION ANALYSIS USING THE WWR NUCLEAR REACTOR. Lisovskii, I. P.; Smakhtin, L. A.; Filippova, N. V.; Volgin, V. I. (Inst. of Physical Chemistry, Moscow). J. Radioanal. Chem.; 8: No. 2, 313-20(Aug 1971).

A semi-automatic pneumatic transport system for nuclear reactors is described. The sealed polyethylene capsules containing the sample are placed into transport containers. Ten such containers are placed manually into a feeding device. All subsequent operations (irradiation, removal of the capsule from the container, and transport of the capsule to the laboratory for activity measurement) are automated. Total time from the completion of irradiation to the beginning of measurement is 10 to 20 sec. (auth)

14539 WALL TEMPERATURE OF FUEL ELEMENTS AS A FUNCTION OF COOLING CONDITIONS DURING REACTOR SHUTDOWN. Slesarevskii, S. O.; Korotenko, M. N.; Nazarchuk, M. M.; Pilipets, D. T.; Stel'makh, S. S. At. Energ. (USSR); 31: No. 5, 515-16(Nov 1971). (In Russian).

Fuel temperature experiments were conducted in the VVR-M reactor (Ukrainian SSR). Two fuel elements with 36% enriched U and attached thermocouples were inserted into the reactor core. Reactor shutdown was accomplished step-wise (10 to a MW). The change in wall temperature of the fuel elements was measured over a 60-sec interval for three conditions: two circulating pumps operating in the primary loop, one pump operating, and cooling by natural convection. Sharp rises in temperatures were noted in the latter two cases. (K.S.W.)

14540 EXPERIMENTAL STUDIES OF 20 PER CENT ENRICHED URANIUM-LIGHT WATER ASSEMBLY. 4. FLUX DISTRIBUTIONS IN FLUX-TRAP TYPE CORE. Inagaki, T.; Aizawa, O.; Miyawaki, Y.; Takeda, E. (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 102, 13-24(Mar 1971).

A flux-trap core was investigated to obtain optimized design features of high flux reactors. The investigation was performed from the experimental side as well as calculations. A small flexible subcritical assembly of the Tokyo Institute of Technology was used for the experiment. It consists of an acryl-resin rectangular box and acryl-resin fuel plate holders which allow 5 rows of fuel plates parallel insertion at intervals of 0.36 cm. The fuel plates contain 20% enriched uranium. Moderator and reflector were light water. Flux mapping type ^{3}He proportional counters were used for measurements. The experimental results showed that the central thermal flux went up rapidly by placing a central trap between the cores. The experimental results for $\frac{1}{2}$ lattice, in which each fuel plate was inserted at every two pitches, showed very good agreement with calculations based on MISA-4 code which treated a nuclear system as an assembly of infinitesimal regions. The experimental results for other lattices did not show good agreement. The disagreement might be due to roughness of treating thermal neutrons in one energy group. Among the assemblies calculated, 1/1-lattice was found to be most excellent. (Japan)

14541 IMPROVEMENTS IN THE MANUFACTURE OF CONCRETE CELLS PROVIDED WITH SEALED LINERS, SUCH AS NUCLEAR REACTOR CELLS OR SWIMMING POOLS. (to Constructions Navales et Industrielles de la Mediterranee). French Patent 2,062,103. 1 Jun 1971. Filed 10 Oct 1969. (In French).

Nuclear reactor swimming pools and cells are constructed of concrete (which provides the necessary biological shielding) and internally lined with an envelope (generally metallic), which ensures fluid tightness. A procedure which utilizes a number of concrete slabs fixed in a frame, the assembly being subsequently buried in concrete, is described. The internal metallic lining is put into position afterwards. ((France)

14542 COLD NEUTRON SOURCE AT FRJ-2 (DIDO). Doose, C.; Stiller, H. H.; Tholen, A. (Kernforschungsanlage, Juelich, Ger.). pp 303-5 of Proceedings of the Third International Cryogenic Engineering Conference. Guildford, Eng.; Iliffe Science and Tech. Publications Ltd. (1970).

From third international cryogenic engineering conference; Berlin, Germany (25 May 1970). See CONF-700522.

The built-in cylindrical ray tube introduction in the research reactor DIDO (FRJ-2) contains a subcooled mixture of about 3 liters of liquid hydrogen and liquid deuterium in a thermosyphon system. About 1,000 cm^3 of this mixture is close to the reactor cores as a moderating substance, while the corresponding energy spectrum of the Maxwell distribution of the thermal neutron flux through spreading in the deep-cold matter is to be relegated to long wavelengths. The required cooling power for the beamport installation is 600 W at 15 K at a reactor power of 15 MW. The sub-thermal flow of neutrons could be increased ten to twenty times for wavelengths over 4 Å and up to 10 Å. (auth)

14543 FRANCO-GERMAN HIGH-FLUX REACTOR OF GRENOBLE. Bregeon, L. (CEN de Saclay, Gif-sur-Yvette, France); Chatoux, J.; Reutler, H. Ind. At.; 15: No. 4, 39-52 (Sep 1971). (In French and English).

The Franco-German high flux reactor at Grenoble is intended for research in solid state and nuclear physics. A thermal neutron flux of 1.5×10^{15} n/cm^2/s is obtained with a 57 MW power. The reactor yield is very good and has interesting characteristics. Three main neutron spectra may be obtained: thermal neutrons in equilibrium with the moderator medium at ordinary temperature, and having the Maxwellian velocity distribution corresponding to this temperature; cold neutron of low energy ($E < 5$ MeV) and long wavelength ($\lambda > 5$ Å) fast neutrons with energies between 100 and 300 MeV (wavelengths between 0.4 and 1 Å). A cold source of liquid deuterium at 25°K and a hot source of graphite at 2000°K allow gain increases of the order of 10 or 100 MeV to be obtained for the neutron flux in the three wavelength ranges, by shifting the spectra with respect to the thermal spectrum at normal temperature. (France)

14544 PNEUMATIC IRRADIATION APPARATUS WITH ON-LINE MEASUREMENT SYSTEM FOR STUDY OF SHORT-LIVED ACTIVITIES. Okano, Kotoyuki; Nakagome, Yoshihiro; Kawase, Yoichi; (and others). Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 84-9(1971).

A pneumatic irradiation apparatus is described which allows automatic recycling of irradiation and measurement according

to a selected time sequence. This apparatus was successfully used for nuclear spectroscopic studies on short-lived radioisotopes and for measurements of fast-neutron spectra of delayed neutron-emitters. Gamma spectra following the β decay of ^{104m}Rh and a new decay scheme of 2.42-min ^{108}Ag are given. (6 figures) (R.W.R.)

14545 EXPERIMENTS FOR THE USE OF PLATES AS SHIM RODS IN REACTORS WITH MTR-TYPE FUEL ELEMENTS. Krull, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie; 18: No. 3, 198-202(Nov 1971). (In German).

Flux density and reactivity measurements of MTR elements with plate-type shim rods have been performed. The influence on the horizontal thermal neutron flux density distribution and on the reactivity worth of the position of the plate-type shim rods in the special fuel elements was measured. The result is that the distance between the two plates should be as large as possible. The reactivity worth of plate-type shim rods made of Ag–In–Cd (80–15–5) is 85% higher than for the old oval-type shim rods. For Cd-plates the dependence on the reactivity worth on Cd thickness was measured. Ag–In–Cd plates have a 16.5% higher reactivity worth than pure Cd-plates. The results give a clear indication for the optimum design of plate type shim rods for MTR-fuel elements. (7 references) (auth)

Rocket and Space Reactors

14546 BENCHMARK GAS CORE CRITICAL EXPERIMENT. Kunze, J. F. (Aerojet Nuclear Corp., Idaho Falls, Idaho); Lofthouse, J. H.; Cooper, C. G.; Hyland, R. E. Nucl. Sci. Eng.; 47: No. 1, 59-65(Jan 1972).

A critical experiment with spherical symmetry was conducted on the gas core nuclear reactor concept. The nonspherical perturbations in the experiment were evaluated experimentally and produce corrections to the observed eigenvalue of <1%Δk. The reactor consisted of a low density, central uranium hexafluoride gaseous core, surrounded by an annulus of void or low density hydrocarbon, which in turn was surrounded with a 97-cm-thick heavy water reflector. (13 references) (auth)

14547 THERMIC THERMIONIC REACTOR WITH CONSTANT EMITTER HEATING FOR THE APPLICATION IN SPACE FLIGHT. Sahin, Suemer (Institut fuer Kernenergetik, Stuttgart). Atomkernenergie; 18: No. 3, 177-88(Nov 1971). (In German).

The neutron physics design of a moderated thermionic reactor for electricity production in a spacecraft is performed. It is required that emitter heating be kept constant over the reactor due to converter physics reasons. Constant emitter heating was achieved by changing the distance between the fuel rods in radial direction and by changing the sintered moderator density axially. The burnup is the same in every fuel element and gross thermal or electrical output power is quite high, owing to the constant emitter heating. Fuel elements are all standard, but the moderator zones differ from each other. A compromise is made between the fabrication cost and the cost of transport into the space orbit. Neutron physics calculations are performed, particularly, by the use of SN-method with anisotropic scattering. (29 references) (auth)

Process Heat and Desalination Reactors

14548 EXPANDING HORIZONS FOR THE HTR. Hosegood, S. B.; Lockett, G. E. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). Ind. At.; 15: No. 4, 25-32(Sep 1971). (In French and English).

The HTR is unique among controlled nuclear energy sources insofar as it can supply heat at temperature levels considerably higher than those needed for the traditional nuclear role of electricity production using steam-driven generating plants. This makes it possible to consider new applications for nuclear energy which have previously been impracticable or the exclusive province of combustion heat sources. A preliminary survey shows that exciting possibilities await exploration in this vast new market. Development of HTR core materials has already reached a point at which nuclear energy can begin to invade this market, given the necessary investment and matching developments in heat transfer and heat utilization. (France)

Marine and Portable Power Reactors

14549 (EUR–4630(Vol.1)) NUCLEAR-PROPELLED TANKER. Final Report. Fedrighini, A. (ed.) (European Atomic Energy Community. Fiat, Turin (Italy). Sezione Energia Nucleare. Ansaldo S.p.A., Genoa (Italy)). 1971. 890p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR Lit. 14,000.

The research and development program carried out in support of the project for a nuclear-propelled tanker is described. This program was carried out in the years 1961–70 along the following four basic lines: the core, the primary internals of the pressure vessel, the shielding and the ship. Within each of these basic lines arguments of various theoretical and experimental interest are set out, the results of which represent a broad and sound basis for a rapid revision of the project data. Vol. I gives a brief description of the methods and equipment used in each individual research project and presents with a commentary the most important results achieved. Vol. II is divided into two parts. Part 1 summarizes the main bibliographical references quoted in Vol. I. Part 2 gives the texts in full of the individual reports published during the R & D program and reissued by the European Communities under an EUR number. (auth)

14550 PROSPECTS FOR NUCLEAR SHIPS. Lewins, J. (University Coll., London). J. Inst. Nucl. Eng.; 12: No. 6, 163-4(Nov-Dec 1971).

It is considered that the recommendation of the Nuclear Ship Study Committee (Report of the Nuclear Ship Study, London, HMSO 1971) that no active work should be carried out by the UK in the field of nuclear marine propulsion, and the acceptance of this by the Government, is based on, among other acceptable factors, an incorrect economic premise. This is that the price of marine fuel oil, in real terms, will fall progressively in the 1980s. The arguments for and against this assumption are examined. The other factors and the detailed economic analysis considered in the study are briefly reviewed. (UK)

Reactor Theory

14551 ANALYSIS OF EXPERIMENTS ON NEUTRON THERMALIZATION IN GRAPHITE–WATER SYSTEMS. Mostovoi, V. I.; Trukhanov, G. Ya.; Safin, Yu. A.; Moskovkin, V. N. At. Energ. (USSR); 31: No. 5, 459-64(Nov 1971). (In Russian).

The space-energy neutron distribution measured by the time-of-flight method at various points in the graphite-water systems at high graphite temperatures is investigated. Comparison is made with the results of the multi-group calculation of the transport equation. Methods for obtaining relaxation and rethermalization lengths from the experimental data are briefly described. The relaxation and rethermalization lengths for graphite and water at various graphite temperatures are given. (12 references) (auth)

Kinetics

Refer also to abstracts 14118, 14192, and 14452.

14552 (ANL–7847) SYN2D: A FLUX-SYNTHESIS PROGRAM BASED ON A DISCONTINUOUS TRIAL-FUNCTION FORMULATION. (Argonne National Lab., Ill.). Jun 1971. Contract W-31-109-eng-38. 245p. Dep. NTIS.

The documentation of the SYN2D computer program is presented. The SYN2D program performs two-dimensional criticality calculations using a single-channel discontinuous-trial-function flux-synthesis technique. It can handle rectangular or cylindrical coordinates, and its alloys for zero flux, zero current, or logarithmic boundary conditions. The trial functions may or may not satisfy the boundary conditions. The SYN2D program is structured as a module in the Argonne Reactor Computation (ARC) System and depends on the output of other ARC System computational modules for its input. 5 references. (auth)

14553 (BNL–50300) DESCRIPTION OF THE ENDF/B PROCESSING CODES AND RETRIEVAL SUBROUTINES. Ozer, Odelli (ed.) (Brookhaven National Lab., Upton, N. Y.). Jun 1971. 123p. (ENDF–110). Dep. NTIS.

The ENDF/B is a pool of evaluated nuclear data to be used in reactor or shielding calculations. This data is stored on a number of magnetic tapes either in the binary mode or in a BCD card image mode. The following programs associated with the data file

of the ENDF/B are described: CRECT; CHECKER; RIGEL; PLOTFB; LISTFC; DICTION; SLAVE-3; and DAMMET. (auth)

14554 (JAERI-M-4381) ONE-DIMENSIONAL DIFFUSION AND PERTURBATION CODE. SIMPLED-D, (NO. 4). Nishimura, Hideo (Japan Atomic Energy Research Inst., Tokyo). Mar 1971. 44p. (In Japanese).

SIMPLE-D, a one-dimensional perturbation code, has been linked with EXPANDA-4, a one-dimensional diffusion code. The code calculates heterogeneity effects of fuel elements with equivalence relation and nuclear characteristics of central void reactors. The theory of the code, the calculations of ZPR-III-48 Core and JEZEBEL core, the input data and their formats to FACOM 230/60, IBM 360/75 and CDC 3600, and the output from these computers are presented. (auth) (Japan)

14555 (JAERI-M-4472) EXPANDA-3 AND EXPANDA-6: THE ONE-DIMENSIONAL DIFFUSION EQUATION CODES FOR FAST REACTORS WITH AN OPTION OF CONCENTRATION ADJUSTMENT. Suzuki, Tomoo (Japan Atomic Energy Research Inst., Tokyo). Jun 1971. 26p. (In Japanese).

The codes EXPANDA-2 and EXPANDA-4 have an option of criticality adjustment by changing the thickness of a region, but the concentration of each element is not changed during calculations. Two computer codes EXPANDA-3 and EXPANDA-6 were developed for treating the concentration adjustment. In these codes the spatial dimensions of a reactor are not varied, but the concentrations of elements in one or more spatial regions can be changed for attaining the criticality condition. The functions of these codes and input format of data are described. In EXPANDA-3 the ABBN group constants set is utilized as library data. On the other hand, in EXPANDA-6 the JAERI-fast set is utilized. The latter code has another advantage of adjusting the concentration of PuO_2 in the PuO_2-UO_2 mixture. Both the codes can also treat simple criticality calculation without adjusting the criticality. (auth) (Japan)

14556 (JPRS-54305, pp 98-104) COMBINATION OF PROGRAMS FOR CALCULATION OF REACTORS AND PROCESSING OF RESULTS OF CRITICAL EXPERIMENTS WITH THE AID OF PERTURBATION THEORY. Zaritskii, S. M. Translated from Byull. Tsentra Yadern. Dannym; No. 6, 289-95(1969).

The basic characteristics of the TVK program, which performs reactor physics calculations and processes data from critical experiments, are described. TVK is a combination of programs all of which are based on perturbation theory. TVK calcluates various reactor parameters as well as processing the results of critical experiments in a form permitting easy checking of the nuclear group constants. A block diagram of the combined programs is given. (J.W.R.)

14557 (JPRS-54305, pp 105-11) CALCULATION OF THE SQUARE MODERATION PATH FOR VARIOUS MEDIA IN 18- AND 26-GROUP P_1-APPROXIMATION AND THEIR COMPARISON WITH EXPERIMENTAL DATA. Marchenko, L. V.; Sergeev, Yu. A. Translated from Byull. Tsentra Yadern. Dannym; No. 6, 319-90 (1969).

Eighteen- and 26-group neutron cross sections are tested by calculating the square moderation path L_1^2 for various media and comparing the results with experimental data. The results for L_1^2 may be of value for low-group calculations of reactor characteristics. The calculations were performed for fission spectrum neutrons in various pure moderators and other compositions containing a moderator. A lack of regularity in the size of the errors for the various systems may be due to lack of consideration of the real heterogeneous geometry of the experimental systems as well as shortcomings in the group constants. (J.W.R.)

14558 (ORNL-TM-3662) CAPABILITIES OF THE MORSE MULTIGROUP MONTE CARLO CODE IN SOLVING REACTOR EIGENVALUE PROBLEMS. Burgart, C. E. (Oak Ridge National Lab., Tenn.). 17 Dec 1971. Contract W-7405-eng-26. 23p. (CONF-720104-1). Dep. NTIS.

From Seminar on numerical reactor calculations; Vienna, Austria (17 Jan 1972).

The method of handling the collision mechanics when utilizing multigroup cross sections in solving reactor problems is described. The capabilities of the multigroup Monte Carlo code MORSE in solving reactor eigenvalue problems are discussed. Quantities routinely calculated for eigenvalue problems include k_{eff}, the mean time to birth, the mean time to death, and average reaction rates in specified spatial regions. These quantities are calculated for several critical configurations, and the usefulness of some of the MORSE capabilities are discussed. 26 references. (H.D.R.)

14559 (RT/FI-(71)23) COMPARISON OF POINT AND SPACE KINETICS IN SIGNIFICANT CASES OF FAST REACTORS. Cecchini, G. P.; Zaccarelli, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 16 Jul 1971. 10p. (In Italian). Dep. NTIS (U. S. Sales Only).

A comparison is presented between point and space kinetics in the calculation of a simulated incident on the PEC fast reactor and for which feedbacks are evaluated with the same procedure. These results show, for the case considered, the inadequacy of point kinetics in the study of localized accidents. 6 references. (auth)

14560 (TKK-F-A-161) MCSUP-OTA: A MONTE CARLO COMPUTER PROGRAM FOR COMPUTATION OF RESONANCE INTEGRALS. Wasastjerna, Frej (Technical Univ. of Helsinki, Otaniemi (Finland). Dept. of Technical Physics). 1971. 56p. Dep. NTIS (U. S. Sales Only).

MCSUP-OTA computes the absorption integral of an isolated Breit-Wigner resonance in a regular square or hexagonal lattice of clad cylindrical fuel rods. This is done through superposition of analytic and Monte Carlo terms. The maximum number of nuclides is one absorber and one pure scatterer in the fuel, one scatterer in the cladding and three scatterers in the moderator. 10 references. (auth) (Finland)

14561 ANALYSIS OF PULSED-SOURCE REACTIVITY DETERMINATION IN A REFLECTED REACTOR. Kondor, A.; Kosaly, G. (Central Research Inst. for Physics, Budapest). J. Nucl. Energy; 25: No. 12, 589-98(Dec 1971).

A study of the kinetic behavior of a reflected slab reactor is presented using a one-group diffusion model. The simplicity of the model makes possible a clear insight into the effects introduced by the reflector. The applicability of corrected versions of the Gozani-method is investigated. (auth) (UK)

14562 CALCULATION OF CRITICAL BUCKLING AND ONE-GROUP FLUX-DISTRIBUTION FOR CORES OF ARBITRARY SHAPE AS A METHOD TO OPTIMIZE CORE GEOMETRIES. Unger, Hermann E. (Northwestern Univ., Evanston, Ill.). J. Nucl. Energy; 25: No. 12, 615-22(Dec 1971).

A variational method, calculating critical size and flux distribution for reactor cores of arbitrary shapes is developed. The flux is approximated by a product of the shape function and a linear combination of trial functions. A unique treatment of a variety of shapes and an analytical integration of the variation integral are possible. The general procedure is developed and programmed for reactors with rotational symmetry and symmetry to the midplane. Numerical results are given. The method is particularly suited for the optimization of core shapes with respect to various technically and economically important reactor parameters like the power peaking factor, void coefficient distribution, etc. The optimization is described and results are shown. (auth) (UK)

14563 THEORY OF SPACE DEPENDENT REACTOR NOISE ANALYSIS USING GAMMA RADIATION. Kostic, Lj.; Seifritz, W. (Technische Univ., Hanover). J. Nucl. Energy; 25: No. 12, 637-55(Dec 1971).

The space dependent theory of the stochastic fluctuations of the prompt gamma flux in a homogeneous infinite multiplying medium at zero power is developed in the frequency domain. The Langevin technique is used to obtain the cross power spectral density as well as the spatial coherence function of the prompt gamma flux fluctuations between two space points in the medium. For this purpose, a new quantity, the so-called Green's function of the gamma flux, is introduced as the response of the prompt gamma flux to the injection of a neutron into the system. The treatment is based on the one and two group energy diffusion model. Special emphasis is devoted to the spatial correlation range of the gammas compared with the neutrons by introducing micro- and macroscales as measures of spatial coherence. The theory is applied numerically to an infinite H_2O-^{235}U system to illustrate the effects of gamma rays upon the spatial correlation range. (auth) (UK)

14564 SOLVING KINETIC EQUATIONS OF A REACTOR. Kuleshov, A. I. At. Energ. (USSR); 31: No. 5, 513-14(Nov 1971). (In Russian).

A system of kinetic equations with six groups of delayed neutrons with given initial conditions are developed. The problem is brought to a form which can be solved by two computer programs, using a step-by-step process. (K.S.W.)

14565 STATISTICAL OPTIMIZATION OF NUCLEAR REACTOR SYSTEM BY MEANS OF MODAL ANALYSIS METHOD. Hara, Fumio (Science Univ. of Tokyo). Nippon Kikai Gakkaishi; 74: No. 629, 755-65(Jun 1971). (In Japanese).

Presented are an outline of the modal analysis method and its application to optimization of nuclear reactor systems, consider-

ing the uncertainty of neutron flux distribution coming from probability aspects of neutron multiplication and transportation processes, and dispersion of various parameters of nuclear reactors. The fundamental equation for the neutron flux distribution is introduced, regarding the neutron multiplication and transportation processes as Marku's branching process. This equation is approximated to the diffusion equation, and mean value and variance of the neutron flux distribution are obtained by the modal analysis method. Maximization of the reactor thermal output was then formed into a mathematical problem for a one-dimensional reactor model. Numerical calculation was carried out by the gradient method. Averaged macroscopic absorption cross sections for each region and each control rod were treated as variable parameters to optimize the reactor. Results of the calculation are as follows. (1) Optimum neutron flux distribution attaching importance to certainty is considerably strained in comparison with the perfectly flat flux distribution from determinate theory, and varies between ±15%. (2) Control rods offer a great deal of effect on the optimum neutron flux distribution. (3) The optimum neutron flux distribution attaching importance to reactor output and taking the certainty into account also becomes flat with ±3% of variation in the central region. (Japan)

14566 NOISE TECHNIQUE FOR MEASURING REACTIVITY INDEPENDENT OF THE NEUTRON GENERATION TIME. Robinson, J. C. (Univ. of Tennessee, Knoxville); Ackermann, N. J. Jr. Nucl. Technol.; 13: No. 3, 250-6(Mar 1972).

A technique was developed for the inference of shutdown reactivity by using the experimental auto- or cross-power spectral density data normally obtained in neutron noise experiments at low and intermediate frequencies (Low-Intermediate Frequency Technique, LIFT). Reactivity determined by LIFT is dependent on the neutron detection efficiency, whereas reactivity determined by normal noise experiments is dependent on the neutron generation time. Furthermore, if a noise experiment is to be used for the inference of reactivity, very little additional experimental data are required for the application of LIFT. It is recommended that LIFT be applied as a complementary measurement to the normal noise measurement. Results determined by LIFT for the shutdown state for previously reported one- and two-detector noise experiments agree well with results determined by normal noise methods. (14 references) (auth)

14567 IMPROVEMENTS TO NEUTRON SLOWING DOWN THEORY FOR FAST REACTORS. Dunn, Floyd E.; Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng.; 47: No. 1, 66-82(Jan 1972).

Continuous neutron slowing down theory has proved useful in problems associated with thermal reactors. There are, however, two principal problem areas which inhibit obtaining the full benefits of continuous neutron slowing down models in fast reactor problems. One problem area is the treatment of inelastic scattering. The second problem area is the treatment of scattering and absorption resonances in a mixture of several moderating materials. New methods are advanced for each of these problem areas. These methods are shown to lead to a continuous neutron slowing down model of reasonable accuracy for fast reactor problems. The inelastic treatment is based on matching the solution for an easily solvable reference problem (the zero absorption case). The mixture treatments (several are considered) are based on averaging procedures over a scattering interval instead of at a single energy. (23 references) (auth)

14568 FORMULATION AND APPLICATION OF ANALYTIC REPRESENTATIONS OF FAST REACTOR FLUX AND IMPORTANCE SPECTRA. Dunn, Floyd E.; Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng.; 47: No. 1, 83-103(Jan 1972).

A model is developed for the study of fast reactor flux and importance spectra. The model is based on slowing down theories of the continuous slowing down type with suitable modifications introduced where such theories are deficient. The ability to obtain analytic solution for the flux and importance spectra depends on the ability to fit basic cross-section ratios (such as the moderating ratio) to simple analytic forms. The cross-section fits are used to obtain an expression for the slowing down density, which generally is a smooth function. Detailed cross sections, however, are used to relate flux and importance to slowing down density. The model yields good agreement with multigroup spectra on both broad group and ultrafine group bases and yields quite accurate values for integral parameters (e.g., criticality and reaction rates). In addition, it is found possible to obtain a good correlation of cross-section fit parameters with composition. (10 references) (auth)

14569 ANISOTROPIC DIFFUSION COEFFICIENT IN GENERALIZED X, Y GEOMETRY: THEORY AND APPLICATION TO DIFFUSION CODES. Michelini, M. (CNEN, Casaccia, Italy). Nucl. Sci. Eng.; 47: No. 1, 116-26(Jan 1972).

In the study of the possibilities of improving the accuracy of diffusion calculations, a point-by-point formulation was established of the diffusion coefficient $D_K(x,y)$ most appropriate to heterogeneous systems comprised of low absorbing media, that is a formulation which contains all the information obtainable from such a system. Since the actual size of each medium is taken into account, this formulation can predict the proper diffusion coefficients even within cavities. Three coefficients, D_x, D_y, and D_z, of anisotropic diffusion are derived for any rectangular elementary region imbedded in a generalized X, Y geometry. They enable more accurate diffusion calculations to be performed in all cases where classical diffusion can be used. In addition, anisotropic diffusion allows the study of non-homogenized cavities. Finally, numerical calculations confirm that anisotropic diffusion is very suitable in many problems. (10 references) (auth)

14570 ANISOTROPIC COLLISION PROBABILITIES IN CELL PROBLEMS. Takeda, Toshikazu; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 12, 663-72(Dec 1971).

A new first-flight collision probability that takes into account the effect of the anisotropic scattering in the moderator is derived in a cylindrical cell. This probability is obtained by expanding the scattering kernel, angular flux and angular source into spherical harmonics series and retaining the first two terms in the integral Boltzmann equation. Making use of a new reciprocity relation and the conservation law, the probability relevant to a lattice cell under the condition that all neutrons impinging on the cell boundary should reflect with isotropic distribution back into the original cell is introduced. This probability also satisfies both the usual reciprocity theorem and the conservation law. Though only a 2-medium problem is treated, the method can be easily extended to the problem of a cell containing many regions. As an example of application, the flux ratios in a two region cell are calculated by one-group theory and the neutron spectra in fuel and moderator are calculated using the Fermi-age kernel in the moderator and wide resonance approximation in the fuel. 9 references. (auth)

14571 ESTIMATION OF THE COUPLING COEFFICIENT AT VARIOUS SUBCRITICAL LEVELS OF A SYMMETRICAL TWO-CORE REACTOR. Leonidou, D. J. (National Technical Univ., Athens); Mansfield, W. K. J. Inst. Nucl. Eng.; 12: No. 6, 171-5(Nov-Dec 1971).

A method is proposed for the experimental evaluation of the coupling coefficient between two loosely coupled symmetrical cores at various subcritical levels of the system. The method is based on a simplified version of Baldwin's kinetic equations, in which the prompt neutron decay constant α is introduced and expressions for the mutual coupling coefficients are deduced. These expressions for the case of a symmetrical two-core system lead to the expression:

$$a = \frac{\beta}{\alpha_{DC}} \cdot e^{-\alpha\tau}\left[\alpha_{DC} - \alpha + \frac{1-k}{\beta}\alpha_{DC}\right]$$

where a is the coupling coefficient, β the effective delayed neutron fraction, α the decay constant · α_{DC} the decay constant at delayed critical and k the effective multiplication factor of each core when "isolated" from the other one. (auth) (UK)

14572 GOERTZEL-GREULING FORM OF THE SLOWING DOWN EQUATIONS. Yamamoto, Hisashi; Ito, Shin-ichi (Atomic Energy Research Lab., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 8: No. 12, 713-15(Dec 1971).

14573 POINT THEORY OF THE NEUTRON NOISE INDUCED BY INLET TEMPERATURE FLUCTUATIONS AND RANDOM MECHANICAL VIBRATIONS. Kosaly, G. (Central Research Inst. for Physics, Budapest); Williams, M. M. R. Atomkernenergie; 18: No. 3, 203-8(Nov 1971).

The influence of inlet coolant temperature fluctuations and random mechanical vibrations of a control rod on the power spectral density of neutronic fluctuations is studied. Using a physically reasonable expression for the power spectral density of the vibrations of the control rod and some results obtained by Robinson for the inlet coolant temperature fluctuations, the resonance like structure observed in experimental measurements of the power spectral density of the Oak Ridge Research Reactor (ORR) is explained. Estimates of the root mean square temperature fluctuations and also data connected with the vibration of the control rod are presented. (19 references) (auth)

14574 CALCULATION AND USE OF SYNTHETIC THERMAL SCATTERING KERNELS. Royl, Peter (Univ., Stuttgart). Atomkernenergie; 18: No. 3, 219-28(Nov 1971).

A review of Cadilhac's formalism is given briefly before the φ_1-, φ_2-fit method to determine the synthetic kernels of the Cadilhac-Model is outlined in detail. The Boltzmann-equation is solved for small absorption by a perturbation method. Special attention has been paid to the asymptotic solutions. They are needed ultimately to determine the thermal scattering sources. The resulting φ_1-, φ_2-functions are used to calculate the isotropic synthetic scattering kernels of the Cadilhac-Model. φ_1-, φ_2-fitted Cadilhac-Functions are presented for gas-scatterers and for H_2O, D_2O, Be and $ZrH_{1.85}$. They were tested by spectrum calculations for infinite homogeneous media. Finally spectra for a strongly heterogeneous cell are presented. They were calculated with these φ_1-, φ_2-fitted functions. Anisotropic scattering was taken into account. The thermal spectra are compared with those from an ANISN S_8 calculation for the same cell. A general relation to describe these cell spectra by Cadilhac's formalism is briefly derived. (13 references) (auth)

14575 NEUTRON NOISE PROBABILITY DISTRIBUTION PARAMETERS BY THE MAXIMUM LIKELIHOOD METHOD. Szeless, Andreas (CEN de Cadarache, Saint Paul Lez Durance, France). Atomkernenergie; 18: No. 3, 209-13(Nov 1971).

The use of the maximum likelihood method for the analysis of reactor noise data in the time domain is described. In particular, the method has been used to determine the two parameters of the distribution of counts, assumed to be a negative binomial, of a neutron detector placed into the reactor. In the past the negative binomial has been fitted by the computation of the mean and variance, or equivalently, the first two moments of the distribution. If the maximum likelihood method is employed instead, then, because of the greater efficiency of the latter in estimating the distribution parameters, a lower number of detection-time intervals can be used as compared to the moments method for the same accuracy. Using the χ^2 goodness to fit test for the estimated negative binomial distributions it was found that the distributions computed according to the maximum likelihood method always produced the smallest χ^2 and hence the closest fit to the experimental data. (10 references) (auth)

Experimental Applications

14576 (JAERI-M-4525) COMPUTER CODE ALPHA-D FOR ANALYSIS OF EXPERIMENTAL DATA IN PULSED NEUTRON TECHNIQUE. Ohkubo, Shuzi; Kaneko, Yoshihiko; Akino, Fujiyoshi (Japan Atomic Energy Research Inst., Tokyo). Jul 1971. 35p. (In Japanese).

Computer code ALPHA-D was developed for data processing in pulsed neutron measurements in a multiplying medium. The purpose of this code is to determine the value of prompt neutron decay constant α_p as accurately as possible by removing the component of delayed neutron decay from the raw experimental data. In the code, the component of delayed neutron decay is estimated as the deviation of the response of the one-point reactor from the exponential decay with the time constant α_p for repeated pulsed neutron bursts. It is found from the application of the code for the test data and for experimental data of pulsed neutron experiment in SHE (Semi-Homogeneous Experiment) that the usual data processing method disregarding the slowly decaying delayed neutron mode underestimates the value of α_p by about 4% in a multiplying medium near critical, having a long neutron life time of about 1 ms. (auth) (Japan)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 11918, 11921, 11936, 11989, 11999, 12021, 12085, 12184, 12614, 12732–12734, 12746, 12770, 12771, and 12804.

14577 (ANL-7852) ANALYSIS OF SOME LOCAL CLADDING STRESS CONCENTRATIONS. A Progress Report. Wang, I-Chih; Weeks, R. W. (Argonne National Lab., Ill.). Oct 1971. Contract W-31-109-eng-38. 30p. Dep. NTIS.

As a first step toward the development of fuel-element failure criteria, a general elasticity solution is derived for a thick cylindrical shell under mechanical-loading conditions that can be expressed in the Fourier Series. Appropriate series are then developed for several loading conditions of interest, namely, radial and tangential loads due to fuel-pellet bamboozing, a radial point loading that might result from fuel chips between fuel pellets and the cladding, and a spiral-line loading that is probably due to the spiral-wire wrap. An outline for numerical solution of the corresponding creep deformation problems is also included. 17 references. (auth)

14578 (ANL-ETD-71-15) TENTATIVE DESIGN GUIDE FOR CALCULATING THE DYNAMIC PLASTIC DEFORMATION OF A CIRCULAR CYLINDRICAL SHELL SUBJECTED TO AN IMPULSIVE PRESSURE. Youngdahl, C. K. (Argonne National Lab., Ill.). Nov 1971. Contract W-31-109-eng-38. 32p. Dep. NTIS.

Circular cylindrical shells in reactor applications, such as for piping, heat exchanger tubing, test loops, pressure vessels, and fuel cladding, may be exposed under accident conditions or normal operation to impulsive pressures over a short portion of their length. A computational procedure is presented for calculating the permanent plastic deformation of a long shell subjected to an impulsive pressure loading having an arbitrary pulse shape and axial variation. An equivalent loading is determined which produces essentially the same permanent deformation and has a rectangular distribution in space and time. A formula is presented for calculating the dynamic plastic deformation produced by the rectangular loading and consequently the deformation caused by the arbitrary impulsive loading. An example problem is solved both analytically and graphically. 5 references. (auth)

14579 (JAERI-M-4500) AN APPROACH TO THE ANALYSIS OF XENON ESCAPE FROM UO_2 DURING POSTIRRADIATION HEATING. Iwamoto, Kazumi, Kikuchi, Teruo (Japan Atomic Energy Research Inst., Tokyo). Jul 1971. 18p. (In Japanese).

The escape of ^{133}Xe from irradiated UO_2 particles was studied by linear-temperature-rise and isothermal heating methods at temperatures below 1700°C. The results obtained were interpreted by Primak's analysis, and the activation energy spectrum distributing in a wide range of the activation energy for the release of ^{133}Xe from traps was obtained. An unspecified process, which plays an important role in the initial short period of the isothermal heating, is involved in the transfer of the ^{133}Xe released from traps. A simple method for estimating the escape fraction of ^{133}Xe in the isothermal heating is proposed, assuming an exponential distribution of the spectrum with activation energy. (auth) (Japan)

14580 (RDT-P-3-1-T(12-71)) ELECTRICAL PENETRATION ASSEMBLIES FOR NUCLEAR REACTOR CONTAINMENT STRUCTURES. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Dec 1971. 15p. RSO.

The requirements for the electrical penetrations and connectors to be used in transmitting electrical power, control, and instrumentation signals between equipment located inside a nuclear reactor containment vessel and facilities located external to the containment vessel are presented. The electrical penetrations will be attached to containment vessel nozzles. (auth)

14581 FABRICATION OF RELIABLE REACTOR COMPONENTS. Fuerste, W.; Schafstall, H. G. (Krupp (Friedr.) GmbH, Essen). Schiff Hafen.; 23: No. 1, 31-4(1971). (In German).

The quality-guaranteeing procedure of the Fried. Krupp GmbH, Essen, for the supply of reactor components is described in 5 sections: quality definition; quality analysis; quality planning; quality documentation; and quality organization. This planned procedure for the standardization of reactor components and testing regulations for reactor construction is meant as a help for future quantitative evaluation of reliability data for reactor components, for the simplification of the licensing procedure, as well as to increase nuclear safety and economy of nuclear power plants. (INIS)

14582 METHOD OF BURN-UP MEASUREMENT BY NONDESTRUCTIVE ANALYSIS OF NUCLEAR FUEL. Okada, Minoru (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 17: No. 4, 51-7(Apr 1971). (In Japanese).

Nondestructive methods of measuring burn-up in reactors are direct gamma-ray spectrometry, indirect gamma-ray spectrometry, activation analysis of stable fission products, and several others. The direct and the indirect gamma-ray spectrometry have been investigated more extensively; by these methods, the burn-up can be measured relatively accurately. The activation analysis of stable fission products is highly promising, in which $\gamma-\gamma$ coincidence counting plays a role. Reviewing works in this field, the following are described: fission products applicable for the burn-up measurement; direct gamma-ray spectrometry (determination of the burn-up and fuel history, movement of fission products through fuel, and gamma-ray spectrometry with semiconductor); indirect gamma-ray spectrometry; and measurement of stable fission products. (Japan)

14583 PROTECTION DEVICE FOR NUCLEAR REACTORS. Wenzel, Peter (to VEB Kernkraftwerksbau). German Patent 1,439,913. 18 Sep 1969. Filed 26 Nov 1960. (In German).

A device is described in which a construction element, preferably a rod, is held magnetically above the active zone in the coolant current or is suspended. It falls by gravity into the active zone on its release. (tr-auth)

14584 RELIABILITY OF 2-OUT-OF-3 SYSTEM CONSIDERING NUMBER OF SPARES AND EXCHANGE TIME. Ito, Taiju; Kawaguchi, Chiyoji (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 12, 696-702 (Dec 1971).

The reliability of a simplified model of reactor instrumentation possessing redundancy in its system is studied. The unreliability is obtained for a 2-out-of-3 system with a limited number of spare units, for the case where the replacement of the failed unit by a spare unit is not instantaneous. Two methods for the solution are obtained. The results are then compared with that obtained from Jacobs' formula for a rate of false scrams, and the accuracy of Jacobs' formula is discussed. It is shown that Jacobs' formula can be used only when the duration of operation is larger than several times the reset time, which must be a constant. But in actuality this reset time depends on such factors as the number of spare units provided, and the time required for replacement. 15 references. (auth)

14585 PROCESS AND DEVICE FOR THE CONTROL AND REGULATION OF NUCLEAR REACTORS. Wenzel, Peter (to VEB Kernkraftwerksbau). German Patent 1,439,915. 18 Sep 1969. Filed 19 Dec 1960. (In German).

A process for the control and regulation of nuclear reactors is described. It is characterized by the fact that the individual components of the reactor possess magnetic (ferro- or ferri-magnetic) properties. The dependence of these properties on the physical-technical parameters, which in turn are dependent on the operational state of the reactors, can be used for the control of the shutdown of the reactor. (tr-auth)

14586 DEVICE FOR SUSPENDING FUEL PINS IN AN ASSEMBLY. Agranier, Jean-Claude; Cayol, Andre (to Commissariat a l'Energie Atomique). French Patent 2,063,107. 9 Jul 1971. Filed 19 Sep 1969. (In French).

A device for suspending fuel pins in an assembly is described. The bundle of pins, which are distributed regularly in a lattice, is supported in an envelope in which the coolant flows. Two parallel supporting rods are attached to the envelope; they are positioned transverse to the direction of the flow. Rails slide on these rods and through the heads of the fuel pins. (France)

14587 DEVICE FOR SUSPENDING FUEL PINS. Agranier, Jean-Claude; Chalony, Andre (to Commissariat a l'Energie Atomique). French Patent 2,060,226. 18 Jun 1971. Filed 17 Sep 1969. (In French).

A device for suspending a bundle of fuel pins in a fuel assembly is described. The pins are distributed regularly in a lattice and are contained in an envelope in which the coolant flows. Two fixed parallel axes traverse a tube held in this envelope. Rails slide through these rods and extend further than the tube edge. Guide pieces slide on each rail and through the heads of the fuel pins. (France)

14588 CALCULATION OF TURBULENT VELOCITY DISTRIBUTION AND WALL SHEAR STRESS IN ASYMMETRIC ROD BUNDLES. Eifler, W.; Nijsing, R. Atomkernenergie; 18: No. 3, 189-97(Nov 1971). (In German).

The calculation of turbulent velocity fields in various asymmetric rod bundles is presented. In the physical model, account is taken of both turbulent diffusion and secondary flow. The numerical examples presented concern the semi-infinite triangular rod array, a three-rod bundle in a triangular channel, seven-rod bundles in a circular channel, nineteen- and other multi-rod bundles in hexagonal channels. The agreement between theoretical predictions and experimental results is satisfactory. (15 references) (auth)

GENERAL

14589 (AEC-tr-7125(Vol.3)) COMPUTER ELEMENTS AND SYSTEMS. VOLUME 3. PROGRAMMING IN COMPUTING MEDIA. Proceedings of a Conference in Novosibirsk, June 1967. Bandman, O. L.; Skorobogatov, V. A. (eds.). Translation of Vychislitel'nye Sistemy. Trudy I. Vsesoyuznoi Konferentsii po Vychislitel'nym Sistenam Prokhodivshei V R. Novosibirske 5–10 Iyunya 1967 G. Vypusk 3. Programmirovanie na Vychislitel'nykh Sredakh. 107p. (TT-70-50013/3). Dep. NTIS.

14590 (BARC-576) SIGFMULA: A CRYSTALLOGRAPHIC PROGRAM FOR SYMBOLIC ADDITION IN CENTROSYMMETRIC CRYSTALS. Sikka, S. K. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 23p. Dep. NTIS (U. S. Sales Only).

14591 (BNL-16410) THERMODYNAMICS OF A SOLVABLE MAGNETIC IMPURITY MODEL. Luther, A.; Emery, V. J. (Brookhaven National Lab., Upton, N. Y.). Jan 1972. 8p. (CONF-711108-12). Dep. NTIS.
From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

14592 (BNL-16411) LOW TEMPERATURE PROPERTIES OF THE KONDO HAMILTONIAN. Emery, V. J.; Luther, A. (Brookhaven National Lab., Upton, N. Y.). Jan 1972. 5p. (CONF-711108-11). Dep. NTIS.
From seventeenth annual conference on magnetism and magnetic materials; Chicago, Ill. (16 Nov 1971).

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